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FINAL REPORT

PREPARED FOR
THE NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER • HOUSTON, TEXAS

CONTRACT NAS9-11949


LMSC
SPACE SYSTEMS
DIVISION

VOLUME II TECHNICAL REPORT PART THREE: PRELIMINARY TEST PLANS

LOCKHEED MISSILES & SPACE COMPANY, INC.
A SUBSIDIARY OF LOCKHEED AIRCRAFT CORPORATION
SUNNYVALE, CALIFORNIA

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SHUTTLE/AGENA STUDY FINAL REPORT

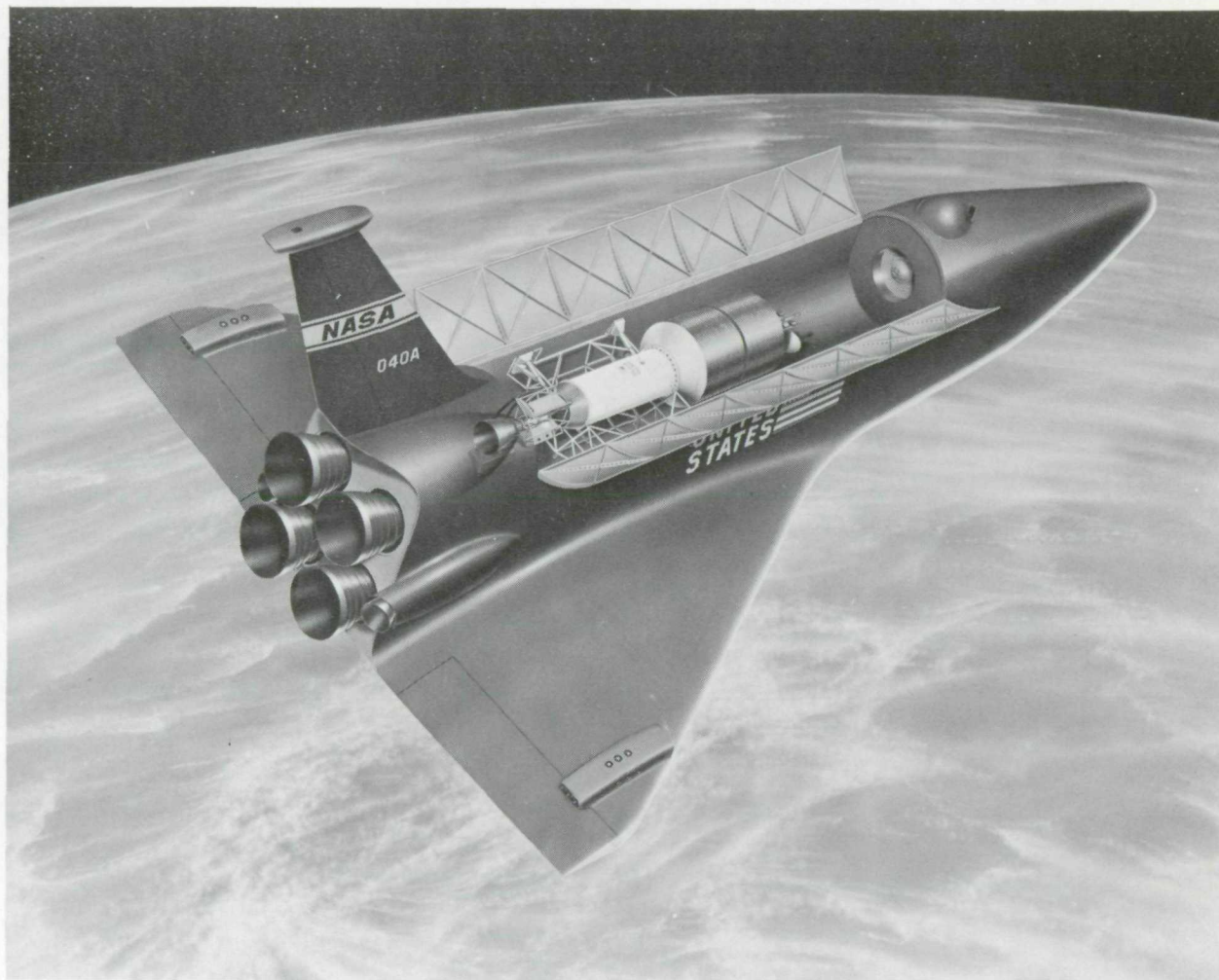
Volume II TECHNICAL REPORT

Part Three PRELIMINARY TEST PLANS

Contract NAS9-11949
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Prepared for the
National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

Lockheed Missiles & Space Company, Inc.
a Subsidiary of Lockheed Aircraft Corporation
Space Systems Division, Sunnyvale, California



FOREWORD

This final report has been prepared for the National Aeronautics and Space Administration's Manned Spacecraft Center, Houston, Texas, under Contract NAS9-11949. Volumes I and II are submitted as DRL line items 6 and 7, as specified in DRD MA-012T and MA-129T of the subject contract. Although not contractually required, supplemental data on the Ascent Agena and existing flight equipment are also submitted.

In compliance with customer guidelines regarding page limitations, the report is bound in separate books as follows:

- | | |
|-------------------------|---|
| ● Volume I | Executive Summary |
| ● Volume II, Part One | Program Requirements, Conclusions, Recommendations |
| ● Volume II, Part Two | Agena Tug Configurations, Performance, Safety, Cost |
| ● Volume II, Part Three | Preliminary Test Plans |
| ● Annex A | Ascent Agena Configuration |
| ● Annex B | Catalog of Existing Flight Equipment |
| ● Annex C | Space Shuttle Candidate Insulator/ Propellant Compatibility Test Program |

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Section 1
INTRODUCTION

Section 1 INTRODUCTION

Proposed testing for the Agena tug program is based upon best estimates of shuttle and Agena tug requirements and upon the Agena configuration currently envisioned to meet these requirements. The proposed tests are presented in four separate test plans as follows:

- Development Test Plan
- Qualification Test Plan
- System Test Plan
- Launch Base Test Plan

The scope of these plans and the depth of test planning are discussed below. Since operational studies and mission data are lacking, these plans have been based upon generalized requirements and assumed situations. Also, the limitations of this study precluded all but minimal consideration of related shuttle orbiter and shuttle ground systems. The test plans do include:

- Provisions for all testing from major component to systems level, identified as necessary to aid in confirmation of the modified Agena configuration for the Space tug
- Considerations that crew safety requirements and new environmental conditions from shuttle interface effects do impose some new Agena testing requirements
- Considerations that many existing Agena flight-qualified components will be utilized and qualification testing will be minimal
- Testing not only for the Agena tug but also for new or modified items of handling or servicing equipment for supporting the Agena factory-to-launch sequence
- The assembly of required testing into a sequence-ordered series of events

1.1 DEFINITION OF THE TEST PLANNING EFFORT

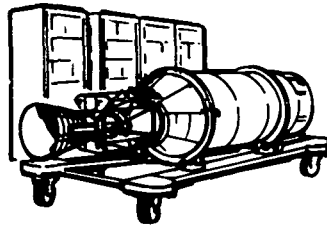
The Agena Tug Development Test Plan outlines the development testing necessary to adapt Agena components and subsystems which have been flight-proven on one or more earlier Agena configurations into an Agena tug configuration generally applicable to a broad spectrum of space tug missions for the Space Shuttle program. The Development Test Plan also reflects the development of some new Agena supporting hardware and shuttle-unique vehicle handling and predeployment operating procedures.

The Agena Tug Qualification Test Plan primarily defines new or additional testing of those equipment designs that must be subjected to environmental testing to establish a fully qualified status for conditions imposed by the Agena tug application. It also is concerned with testing of new equipment unique to shuttle tug requirements, such as the cradle to support the Agena in the orbiter payload bay and the Agena/payload service panel.

The System Test Plan and the Launch Base Test Plan require that Agena tug systems successfully complete all testing before leaving the factory. In addition, all prelaunch preparations feasible to be performed at the factory shall be completed before shipment. This is referred to as the factory-to-pad concept.

The Agena Tug System Test Plan projects an acceptance test program for the baseline vehicle configuration of the Agena tug and tug-supporting flight equipment for the orbiter payload bay. It defines necessary acceptance testing activities associated with the vehicle assembly from initial manufacturing and acceptance testing of components and assemblies through total vehicle integrated system tests and preparation for shipment to the launch base. The detailed tests will demonstrate that the vehicle meets acceptance requirements for the Agena tug configuration.

The Launch Base Test Plan starts with receiving inspection of the Agena tug at the launch base; continues through a succession of integrations and system test checkouts with ground support equipment, Agena payload, and orbiter; and culminates with Agena activities up to launch of the shuttle.



SYSTEM TEST

1.2 DEFINITION OF SYSTEM TESTS

System tests of the Agena tug used in these test plans refer to the sequenced testing of a complete integrated Agena vehicle (with payload simulation as required) to exercise all vehicle subsystems under simulated flight sequences and demonstrate total vehicle acceptability.

The System Test Plan encompasses:

- Manufacturing tests performed in the manufacturing areas during fabrication and assembly operations
- Vehicle system tests as defined above, performed with Agena-unique system test and checkout hardware and software test tapes

Manufacturing tests are included in the System Test Plan for expediency and reference. Components are tested and accepted to component specifications prior to incorporation into the vehicle systems. Vehicle system tests are directive in nature and demonstrate compliance with the Agena vehicle model specification.

The combination of manufacturing tests and vehicle system tests makes up the complete test history of an Agena vehicle and is the Agena tug vehicle acceptance test program.

In the Launch Base Test Plan, the system tests previously performed at the factory are substantially repeated as appropriate as the total Agena vehicle is integrated with Agena payload and orbiter systems. In particular, the system test is rerun, first as a compatibility check with launch base ground support equipment (COMPATS) and then after assembly of the Agena tug with the Agena payload (system test). The purpose of system

tests at the launch base is the same as system tests at the factory – to check that the vehicle (after the addition of these other systems) is functioning as an integrated system.

After system tests at the launch base, the flight tape which is tailored to each specific flight or mission is loaded into the Agena tug computer. The flight tape is a key element – it contains the guidance philosophy, control laws, basic computational instructions, and overall executive routine for the total Agena tug vehicle system. However, it contains health and status checks and thus has a more limited system test capability commensurate with preflight and predeployment checkout requirements.

1.3 SCOPE

These test plans cover:

- The Agena tug vehicle
- The vehicle-supporting cradle which supports the loaded Agena tug before and during installation in the orbiter payload bay and provides the mechanical attachment interface between the orbiter and the Agena tug in the payload bay
- The propellant tank supporting rings associated with the cradle
- The Agena/payload service panel associated with the shuttle interface unit for semipermanent installation in the payload bay
- An Agena tug mockup for the Agena tug and orbiter payload bay development

At the component level, several Agena tug components requiring development activity are included in the Development Test Plan. Included in the Qualification Test Plan are lists of currently qualified equipment and new or modified designs of flight systems and support equipment requiring qualification or requalification.

Facilities for development, qualification, and system tests are presently available and are identified in these respective test plans. Equipment and facilities required for launch base tests are identified or referenced in the Launch Base Test Plan. Particularly, the Agena tug Readiness Area associated with or incorporated into the Payload Processing Facility is generally described.

Operational safety during prelaunch activities is covered under the "Policies and Constraints" section of the Launch Base Test Plan.

Software development programs have been omitted from these plans for several reasons:

- Operational studies are not presently available.
- Definition of mission requirements is incomplete.
- Interfaces between Agena ground station equipment, shuttle Mission Control, and orbiter ground station have not been defined.
- Definitive requirements and operational needs of the orbiter payload control console are not available.
- Software requirements may be strongly influenced by short-duration mission timelines and short payload turnaround times. This is particularly true of the Agena tug flight tape.
- Payload and mission requirements are generally beyond the scope of the present study.

The Agena tug flight tape generated for each flight or mission will be comparable to present Agena flight tapes. However, rapidly changing payloads and variations in mission requirements or deployment parameters identified by future operational studies may dictate new requirements. Also, new software requirements may be imposed by development of payload control console concepts and by future identification of a need to load a new flight tape from the payload control console.

Certain items outside of the scope of this study such as requirements imposed by specific missions or specific payloads or flight and ground hardware and software on the orbiter side of the Agena/payload service panel are referred to incidentally or for informational purposes. These include:

- Components applicable to one or more of the baseline missions. (Refer to the System Test Plan.)
- Mission-dependent subsystem variations which may have an impact on the configuration, development of and/or schedule/cost effectiveness of standard Agena tug subsystems. (For example, an integrated IGS/DACS guidance system.)

- Non-Agena equipment which may be required for design, development, or checkout of Agena tug hardware. (For example, the GFE orbiter power and the data bus simulator.)
- Orbiter equipment on the orbiter side of the Agena/payload service panel closely interrelated both to requirements imposed on and imposed by the Agena tug. (For example, the payload control console for Agena tug flights.)

1.4 DEPTH OF TEST PLANNING

The four test plans included in this report deal with test details in varying depth. The Qualification Test Plan and the System Test Plan are generally explicit; they are based upon similar plans developed for many Agenas previously flown.

The Launch Base Test Plan may be considered as a receiving inspection followed by five stages of activity:

1. Testing compatibility with ground support equipment (COMPATS)
2. System test with payload (system test)
3. RF checkout with orbiter
4. Integrated tests with Agena installed in orbiter payload bay
5. Countdown activities before shuttle launch

The first two stages closely parallel existing launch base test activities for Agena vehicles. The remaining stages are dependent in varying degrees upon modified or new requirements imposed by the shuttle applications.

The Development Test Plan is unique to the tug application and is subject to particularization as shuttle and mission requirements are more clearly defined.

1.5 LIMITATIONS OF TEST PLANNING

The Agena tug test plans are based upon undefinitized best estimates of space tug operational and mission requirements. Because definition of mission requirements is incomplete, minor discrepancies in the test planning area remain unresolved. However,

these deficiencies do not compromise the validity of the basic test planning effort for the Agena tug program. Most of the test planning presented herein correlates closely with long-term Agena experience. When deployment of the Agena tug from the orbiter is related to launch of an Ascent Agena, operational and mission requirements anticipated for the Agena tug follow the changing requirements pattern usually met by past Agena flights.

1.6 TEST SCHEDULES AND SEQUENCES

Test schedules shown in these Agena tug test plans are tentative and are based upon preliminary definitions of requirements. Early Agena tug development tests and mockup activity are heavily dependent upon concurrent development and interplay of requirements definition between the orbiter and tug programs. This is obvious in the areas of interface equipment (such as Agena/payload support cradles); this relationship will also become apparent as operational studies proceed and specific requirements, capabilities, and limitations in one area (for example, the payload control console) influence the definition of potential requirements in other areas (such as specific shuttle tug built-in command and checkout capabilities, software requirements, etc.).

An overview of the Agena tug test schedule is shown in Fig. 1-1. Except for final countdown activities when Agena tug activities are minimal, the tentative test schedules are based upon conservative 5-day-week, one-shift-per-day operations. Consequently, schedule time can be reduced if necessary by multiple shift scheduling, thus providing flexibility to meet customer requirements. However, certain operations during system tests can be conducted most efficiently if the handover necessitated by multiple shift operations can be avoided.

1.7 TESTING APPLICATION

The application of Agena tug testing with reference to the four test plans following is given in Table 1-1. The following abbreviations are used in this table:

| | |
|------|------------------------------|
| DACS | Dual attitude control system |
| EMI | Electromagnetic interference |

| | |
|------|--------------------------------|
| GFE | Government-furnished equipment |
| GSE | Ground support equipment |
| IGS | Inertial guidance system |
| ISA | Inertial sensor assembly |
| NT | No test |
| PIV | Propellant isolation valve |
| P/L | Payload |
| RF | Radio frequency |
| TT&C | Tracking, telemetry, & command |

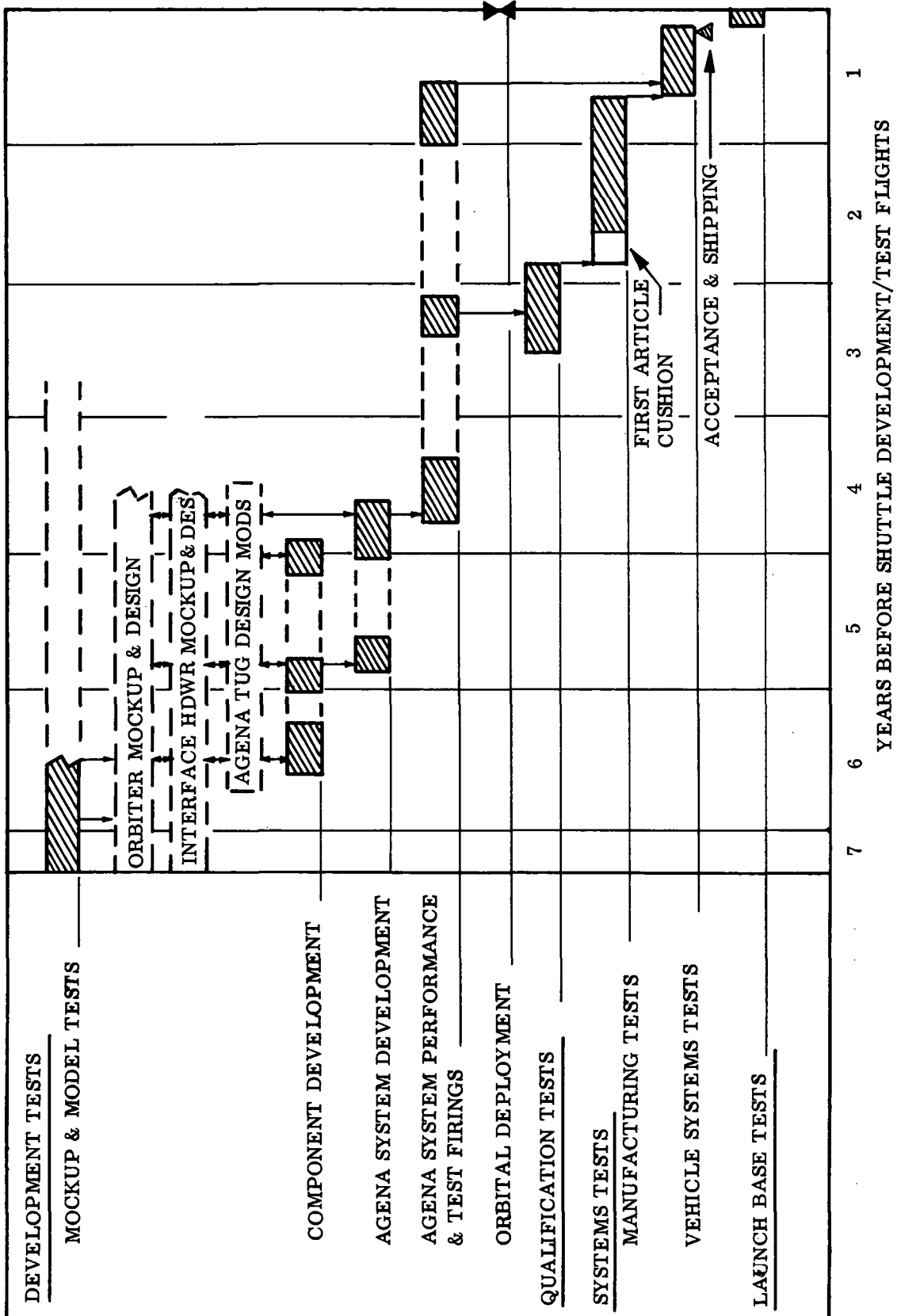


Fig. 1-1 Agena Tug Test Schedule

Table 1-1
APPLICATION OF AGENA TUG TESTING

| Application of Test | Test Plan | | | | |
|-------------------------------|---------------------|------------------------|------------------|-----------|--------------------------------|
| | Dev Test Plan | Qualif Test Plan | System Test Plan | | Launch Base Test Plan |
| | | | Mfg Test | Syst Test | |
| Agena Tug | | | | | |
| General | | | | | |
| Agena Tug Mockup | X | | | | |
| Alignments | | | X | | X |
| Spaceframe (Structural) | X | | | | |
| Propulsion System | | | | X | |
| Multistart Engine | X | NT | | | X |
| Agena Tug Static Firing | X | | | | |
| Gas Generator Valve | | X | | | |
| Dual Check Valve | | X | | | |
| Pressurization System | | | X | | X |
| Pressurization Tanks | X | X | | | |
| Pressure Regulation | X | X | | | |
| Propellant Vent Relief Valve | | X | | | |
| Vent Line Shutoff Valve | X | X | | | |
| Propellant Syst-Gen | | | | | X |
| Propellant Mgt Syst & Sump | X | NT | | | |
| PIV | X | | | | X |
| Propellant Dump System | X | X | | | X |
| Propellant Dump Control Valve | | X | | | |
| Propellant Exposure | X | | | | |
| Safety Instrumentation | X | X | | | |
| Electrical Power | | | | X | |
| Battery | | | X | | X |
| Solar Array | X | | | X | |
| Guidance & Control | | | | X | |
| IGS & ISA | X | X | | X | |
| Pneumatic Control System | | | X | X | X |
| Hydraulic Control System | | | X | X | |
| Optical Alignment | | | | | X |
| Integrated IGS/DACS | X | | | X | |

Table 1-1 (Cont)

| Application of Test | Test Plan | | | | |
|---|---------------------|------------------------|------------------|-----------|--------------------------------|
| | Dev Test Plan | Qualif Test Plan | System Test Plan | | Launch Base Test Plan |
| | | | Mfg Test | Syst Test | |
| Agena Tug (cont) | | | | | |
| Communications (TT&C) | | | | X | X |
| RF Data System | X | | | | |
| Command System | X | X | | | |
| Flight Control Electronics | | X | | | |
| Antenna | | | X | | |
| Battery Activation | | | | | X |
| Battery Installation | | | X | | X |
| Solar Panel | | | | | |
| EMI | | | | X | |
| Pyrotechnics | | | | X | X |
| Agena-Related Equipment | | | | | |
| Vehicle-Supporting Cradle | X | X | X | | |
| Agena/Payload Service Panel | X | X | | X | |
| Agena Support/Constraint & Release System | X | | | | |
| Umbilical Release & Retraction | X | | | | |
| Agena Tug Interface Simulator | X | | | | |
| Agena Tug Operations & Agena GSE | | | | | |
| GSE-General | | | | X | X |
| Flight Simulation & Readiness | | | | X | X |
| Agena Tug/Cradle Mating | | | | | X |
| Agena Tug/Payload Mating | | | | | X |
| Propellant Loading | | | | | X |
| Propellant Vacuum Drying | X | | | | X |
| Agena Tug Storage | | | | | X |
| Agena Tug/Orbiter Mating | | | | | X |
| Countdown | | | | | X |
| Orbital Deployment | X | | | | |
| Payload & Mission Oriented | | | | | |
| Integrated IGS/DACS | X | | | X | |
| RF Power Amplifier | | X | | | |
| Solar Panel | X | | | X | |
| Payload Mating | | | | | X |
| Shuttle Equipment & GFE | | | | | |
| Orbiter Payload Control Console | X | | | | |
| Shuttle/Orbiter Power & Data Bus Simulator | X | | | | |

Section 2
DEVELOPMENT TEST PLAN

Section 2
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DEFINITION OF TERMS AND ABBREVIATIONS

| | |
|------------------------------|--|
| Agena/payload service panel | Service panel in orbiter cargo bay. Provides electrical and dump line interface between Agena and orbiter systems (data bus, payload command/control console, and telemetry encoder). |
| AGS | Ascent guidance system |
| ADS | Automatic data set. Part of command input equipment to Agena. |
| CSE | Chief Systems Engineer |
| Cradle | Vehicle-supporting cradle for supporting Agena and payload in ground tests and for interfacing with orbiter in payload bay. |
| CSD | Cross power spectral density. See acoustic tests. |
| DACS | Dual attitude control system |
| GFE | Government-furnished equipment |
| GSE | Ground service equipment |
| HDA | High-density acid. Improved Agena propellant oxidizer. |
| HPP | Hydraulic power package |
| IGS | Inertial guidance system |
| IRP | Inertial reference package |
| ISA | Inertial sensor assembly |
| ITP | Integrated test program. For guidance system tests. |
| LMSC | Lockheed Missiles & Space Co., Inc. |
| MPS | Main propulsion system |
| Mission specialist's station | Station in orbiter for orbiter crew member in charge of mission/payload operations. Station includes Agena/payload control console, safety monitor, connections to orbiter data bus. |
| NASA | National Aeronautics & Space Administration |
| OPE | Orbiter payload equipment |
| P/L | Payload. Agena payload refers to the mission-oriented equipment attached to the forward end of the Agena. Shuttle payload refers in limited sense to combined Agena and Agena P/L; in general sense, to all onboard equipment and personnel chargeable to P/L. |

| | |
|-------------------------|--|
| Payload control console | (See mission specialist's station; also, systems test set.) |
| PCU | Power control unit. Part of systems test set. |
| PSD | Power spectral density. See acoustic tests. |
| PIV | Propellant isolation valve |
| PRN | Pseudo random noise range code |
| RF | Radio frequency |
| SAFE | Shuttle/Agena flight equipment. Shuttle/Agena unique equipment semipermanently installed aboard the orbiter |
| SIU | Shuttle interface unit. Refer to Agena/payload service panel |
| SOPE | Standard orbiter payload equipment |
| SCU | System control unit. Part of systems test set. The SCU controls the guidance system via the Agena computer. It contains logic for power control and sequencing, computer loading, and buffering between computer I/O and the automatic data set. |
| STS | Systems test set. The STS consists of a system control unit and a power control unit. The STS with the automatic data set provides the capability to conduct tests and control the Agena systems at the launch site and in flight before deployment. |
| TLM | Telemetry |
| TBD | To be determined |

1.0 INTRODUCTION AND SUMMARY

The NASA Shuttle/Agena Study was conducted to investigate the feasibility of adapting LMSC's flight-proven Agena space vehicle as a space tug that would be launched from the payload bay of the shuttle orbiter while in earth orbit. The expendable Agena tug would then operate independently of the recoverable orbiter to place one or more payloads into one or more space trajectories or orbits.

This development test plan presents an outline of the developmental testing required to adapt generally flight-proven hardware from several Agena configurations into an Agena configuration particularly adapted to the operational and mission requirements of the NASA Space Shuttle program. Major objectives of the testing described in this development test plan are as follows:

- Investigate, develop, and check requirements unique to the shuttle/Agena space tug application.
- Obtain development test data to further the engineering design of vehicle equipment and to specify performance parameters.
- Select as a result of testing specific subsystem design configurations and components.
- Check and measure performance as the result of subsystem configuration changes.
- Demonstrate through testing and analysis of test results that proposed changes will satisfactorily meet shuttle/Agena tug requirements.
- Investigate and develop operating procedures for ground, preflight, and space-flight operations.
- Confirm or advance design to the ultimate hardware configuration and develop data and other criteria to be used for specifying, qualifying, and accepting shuttle/Agena tug hardware.

2.0 SCOPE

In the Agena tug development test plan, the differences in vehicle design requirements, operational requirements, and supporting equipment requirements (flight and ground)

are examined and the developmental testing requirements for the Agena and Agena-related equipment are projected. This development test plan does not include:

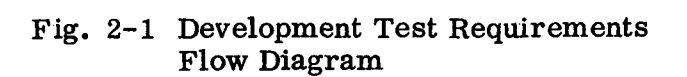
- Development of payload adapters or integration of specific payloads
- Tests of the orbiter payload bay or other shuttle structure or equipment
- Payload bay environmental tests
- Tests of shuttle GSE which may be required to support payload or Agena operations
- Shuttle payload deployment mechanisms or equipment (shuttle equipment)

Qualification testing and the acceptance testing required under this program are covered under separate test plans.

The specific development tests called for, which are detailed in Section 5.0 of this plan, are outlined below and also shown graphically in Fig. 2-1.

- Agena Vehicle
 - Propellant Management System Tests
 - Agena Tug Structural Deformation Test
 - Multistart Engine Tests With HDA
 - Safety of Pressurization Storage System Tests
 - Modified PIV Pressure Drop and Sealing Tests
 - PIV Vent Line Shutoff Valve Tests
 - Engine and Propellant System Exposure Time Limitation Tests
 - Propellant Leakage Detection Test
 - Pressure Regulation System Tests
 - Static Firing Tests
 - RF Data Tests
 - Command System Tests
 - Integrated Inertial Guidance System/Dual Attitude Control Systems Test*
 - Inertial Guidance System Acoustic Tests
 - Solar Panel Deployment Tests*

* Mission/payload oriented



- Support Equipment

Agena Tug Mockup for Orbiter Payload Bay Tests

Orbiter Payload Control Console Mockup*

Vehicle-Supporting Cradle Static Load Tests

Orbiter Power and Data Bus Simulator Tests**

Orbiter Payload Control Console for Agena Tug Flight Tests

Agena Payload Service Panel Functional Development Tests

Interface Simulator Tests

- Operational Development

Agena Tug Structural Deformation Tests

Propellant Dump Time Tests

Vacuum Drying Tests

Agena Support/Constraint System Tests

Umbilical Release and Retraction Tests

Orbital Deployment Tests

3.0 RESPONSIBILITIES

Lockheed Missiles & Space Co. will have overall responsibility for development of:

- Agena tug vehicle, components, and equipment
- Equipment for the orbiter and Agena-related flight equipment which is unique to the Agena or Agena payload (i. e., Agena/payload control console, Agena/payload service panel, Agena vehicle-supporting cradle, etc.)
- Activities integrating the Agena and Agena payload into shuttle and shuttle-related equipment and operations

The National Aeronautics & Space Administration and supporting shuttle contractors will be responsible for development of:

- Shuttle and orbiter equipment and payload-related equipment which is considered standard or common to shuttle payloads

* Mission/payload oriented

**Government furnished

- Equipment which simulates shuttle or orbiter-related equipment which may be required for development or checkout the Agena tug or Agena-related equipment
- Overall mockups of the shuttle payload and control areas, such as the payload bay and the mission specialist's station

As LMSC subcontractor, the Bell Aerospace Co. will be responsible for assigned developmental activities related to the main propulsion system.

Within LMSC, the LMSC program office will provide administrative and technical guidance; approve test requirements, plans, and procedures; control schedules and budget; and be responsible for the successful completion of the Agena tug development program specified in this plan.

The LMSC Agena tug Chief Systems Engineer (CSE) will have overall LMSC responsibility for technical and engineering activities on the Agena tug. This includes approving design, testing, and technical operational changes related to the Agena tug and Agena payload and accepting results and test reports.

LMSC Engineering will be technically responsible to the CSE and the LMSC program office for all phases of the test program including, but not limited to, approval of the tests and procedures outlined in this test plan, evaluation and approval of the test results, and review of test reports.

Assigned test agencies (LMSC test laboratories, vendors, or subcontractors) will be responsible for the preparation of test procedures, the performance of tests, and preparation of data sheets and laboratory test reports. Engineering and the assigned test agencies will be jointly responsible for recording and controlling the configuration of test specimens and the conditions of the tests for all significant phases of any development test program.

4.0 DEVELOPMENT TEST METHODS

Development tests will not be undertaken or expanded in scope without the cognizance and formal approval of the LMSC Agena tug program office and the Chief System Development Engineer acting for the Agena tug CSE.

LMSC Engineering will provide technical direction and continuous monitoring of development test methods employed and test results obtained.

Test procedures will be prepared by the performing test agency. Prior approval of test procedures for most development tests is required. The requirement to prepare a test procedure for a development test may be waived by the LMSC Agena tug program office and the Agena tug CSE upon the recommendation of Engineering if design has not advanced to sufficient degree to permit good definition of the testing required. Generally, test procedures will be detailed step-by-step instructions which will define test levels, identify equipment to be used, state accuracy, and provide test data sheets. Development test procedures may be less formal, but will at least define the test concept and provide a record of the configuration tested, may discuss equipment limitations and accuracy, and will establish the method of presenting data and/or reporting.

Development test procedures of parts and components need approval only by Agena tug Engineering. Development test procedures for major subsystems require approval by Engineering with at least informal coordination with the Chief Systems Development Engineer. Development tests of the total Agena vehicle or those involving vehicle performance or items interfacing with shuttle or orbiter systems or their support equipment require the approval of the CSE or his deputy, the Chief Systems Development Engineer.

Subcontractor/vendor test procedures will be prepared in accordance with established subcontractor/vendor methods and will be subject to review and concurrence by LMSC Engineering, the CSE, and the LMSC program office.

The LMSC CSE or the Chief Systems Development Engineer will be kept informed of all development test progress and will be notified in advance when any major development test is to be performed.

A continuous and permanent record of changes in configuration of the development test specimen will be maintained by Engineering. If development tests are conducted by vendors/subcontractors, test specimen configuration records will be maintained by the testing agency.

During development tests, failure of a test specimen to perform as prescribed by the test assignment will be reported by Engineering and the testing organization immediately to the requestor and documented by flash report to the requestor and to all in the approval and coordination cycle.

Failure reporting and corrective action for subcontractor/vendor activities will be in accordance with established subcontractor/vendor methods. Failure reports are subject to review and concurrence by LMSC Engineering. For failures at LMSC or subcontractors, the CSE and Engineering representatives will be mutually responsible for ensuring that the effect of the failure upon the design is properly evaluated and corrective action measures applied.

All failure reports will contain the following information as a minimum:

- a. Test specimen configuration and identification
- b. Conditions under which test failure occurred
- c. Preceding tests conducted on the unit and operation time of the unit prior to failure
- d. Test results obtained from the failed unit
- e. Specified acceptable limits of performance of the unit

Permanent records of development test data will be made and retained by the testing organization until superseded by later acceptable data and released by the responsible Engineering organization. Recorded raw data and resulting processed data in the form of data sheets, graphs, plots, or other presentations will become a part of the test reports as defined in the approved development test procedure. If not otherwise specified, test data will be retained a minimum of 2 years or until released by the program office.

The originals of subcontractor/vendor-generated test data will be retained by the subcontractor/vendor a minimum of 2 years. The period of data retention will be established by the subcontractor/vendor contracts.

Two types of test reports, flash reports and final reports, will be used to formally transmit results of testing:

- a. Flash reports will be prepared by the test agency and issued as a means of informing Engineering and the LMSC program office of the technical progress being made on a test assignment. They will be issued upon, but not limited to, the following occasions and within the time period specified:
 - (1) Conclusion of a significant test or phase of testing (within 3 days)
 - (2) Failure of a test specimen to perform as expected or required (within 24 hours)
 - (3) Need to explain or document special test program developments (within 3 days)
 - (4) Inability to continue the test program due to material shortages, test equipment breakdown, etc. (within 24 hours)

Flash reports will contain data and be distributed as described above.

- b. For each test or tested component, subsystem or vehicle, a formal final report may be required of the test agency as required by the approved procedures. Normally, the final report will contain as a minimum the following technical information:
 - (1) Abstract of the test
 - (2) Definition of the configuration tested
 - (3) Copies of test procedures used
 - (4) Copies of completed data sheets and reduced data
 - (5) Discussion and description of the test, including any anomalies which occurred during the testing

The final report will be reviewed by Program Engineering and the test results analyzed before release.

Technical control of development testing will be achieved through Engineering design reviews; specification and testing requirements; review and approval of test procedures; recording of test specimen configurations; Engineering monitoring of tests; progress reporting; failure reporting; and final reports, performance specifications, or final design drawings or specifications as required by the development test requirement and the approved test procedure.

5.0 DEVELOPMENT TEST REQUIREMENT

Development tests required for the Agena tug are outlined in the following pages. These requirements, shown graphically in the Development Test Requirements Flow Diagram (Fig. 2-1), are listed below:

- Orbiter Payload Control Console Mockup
- Agena Tug Mockup for Orbiter Payload Bay Tests
- Vehicle-Supporting Cradle Static-Load Tests
- Agena Structural Deformation Test
- RF Data Test
- Command System Test
- Integrated Internal Guidance System/Dual Attitude Control System Tests
- Inertial Guidance System (IGS) Acoustic Test
- Propellant Management System Model Tests
- Safety of Pressurization Storage System
- Modified Propellant Isolation Valve (PIV) Pressure Drop and Sealing Test
- PIV Vent Line Shutoff Valve Test
- Multistart Engine Tests with HDA
- Engine and Propellant System Exposure Time Limitation Tests
- Pressure Regulation System Tests
- Propellant Dump-Time Test
- Propellant Leak-Detection Tests
- Vacuum Drying Test
- Agena Tug Static Firing Test
- Solar Panel Deployment Tests
- Orbiter Power and Data Bus Simulator Test
- Agena Interface Simulator Test
- Agena/Payload Service Panel Functional Development Tests
- Orbiter Payload Control Console for Agena Tug Flights
- Agena Support/Constraint System Release Tests
- Umbilical Release and Retraction Tests
- Orbital Deployment Tests

The sequence and scheduling of Agena tug development testing is TBD.

5.1 ORBITER PAYLOAD CONTROL CONSOLE MOCKUP

Situation: The Orbiter will have a manned mission specialist's station with an Agena tug payload control console as part of the equipment. The payload control console, which can be developed from existing Agena program support equipment, may include:

- An automatic data set (ADS), a typewriter-tape input device
- A modified systems test set (STS). The STS presently consists of a system control unit (SCU) and a power control unit (PCU). The STS with the ADS will provide the capability to conduct tests and control the Agena systems at the launch site and in flight before deployment. The test capability presently includes software checkout, interface testing, and integrated system testing.

The SCU has the capability to control the system via the Agena computer. Printed circuit boards contain the logic for power control and sequencing, manual and automatic computer loading, and interface buffering between computer I/O and the ADS. The SCU will contain necessary power conversion and regulation equipment. The front panel will contain switches and indicators required for loading and readout of computer memory and for power and system control.

- An Agena guidance computer (GC) interface unit will contain the logic, loads, switches, and indicators necessary to control, stimulate, load, and monitor the GC during testing.
- A tape read-in device for sending commands to the Agena both before and after deployment
- A cathode ray (CR) monitor
- An electronic interface unit to interface with the orbiter data bus
- A power unit to interface with orbiter power
- Agena safety instrumentation
- Agena emergency propellant dump control
- Agena deployment control equipment

This Agena unique equipment, which is semipermanently installed aboard the orbiter, is collectively referred to as shuttle/Agena flight equipment (SAFE).

The payload control station also will have certain standard Orbiter equipment which has direct application to Agena and payload operations but which is not unique to the

Agena or Agena payload. This standard orbiter equipment, which is outside of the scope of this development test plan, includes:

- Payload power control and interrupt; i. e., orbiter power to the Agena/payload service panel/shuttle interface unit (SIU)
- A recording device to record Agena commands transmitted from the shuttle ground station
- A payload bay monitor
- Necessary monitors of orbiter power and data bus which will affect payload operations

This standard orbiter payload equipment which interfaces with the Agena operationally is collectively referred to as SOPE.

NOTE

Certain SAFE and SOPE may be combined or share common use depending on undefined design constraints and requirements. These possibilities include:

- SAFE tape reader and SOPE recording device
- SAFE CR monitor and SOPE payload deployment monitor

Objective: To develop an Agena tug payload control console mockup suitable for installation in the orbiter at the payload control station to support, control, and monitor necessary Agena tug safety, predeployment checkout, and orbiter flight operations.

Test Specimen: A full-scale mockup compatible with orbiter space requirements and Orbiter/Agena tug operating requirements.

Test Facilities: Orbiter mockup.

Test Description: Develop in full-scale mockup an Agena-unique console which will be compatible with the orbiter payload command and control station requirements. Perform human factors and operational safety analyses.

Test Data Required: Control console design requirements, safety and human factors analyses, recommended operating procedures and sequences.

5.2 AGENA TUG MOCKUP FOR ORBITER PAYLOAD BAY TESTS

Situation: The orbiter will have an Agena tug (with payload) supported on a cradle installed in the payload bay, along with certain orbiter equipment such as the payload deployment mechanism, payload bay/Agena cradle tiedown points, and cranes and slings to install the Agena tug in the payload bay which must interface with the Agena and/or Agena equipment.

Objective: To develop an Agena tug mockup and ancillary Agena equipment to check for physical compatibility between the Agena and the orbiter and supporting equipment and to provide the mockup to NASA or NASA orbiter subcontractor.

Test Specimen: Physical (essentially nonfunctional) mockup of the Agena and Agena/payload service panel. Vehicle-supporting cradle mockup and Agena tug mockup shall be functionally simulated as needed in regard to attach and release points between:

- Cradle and payload bay
- Cradle and dolly
- Cradle and Agena
- Cradle and/or Agena and payload bay installation crane
- Agena attach points for orbiter deployment mechanism

A physically simulated Agena payload shall be required.

Test Facilities: Mockup storage and handling area and equipment.

Test Description: Assist orbiter contractor personnel in developing interfaces and assuring physical compatibility.

Test Data Required: Engineering final design requirements.

5.3 VEHICLE-SUPPORTING CRADLE STATIC-LOAD TESTS

Situation: A vehicle-supporting cradle with rings to support the loaded propellant tanks is required for holding and moving the Agena tug with propellants loaded. This cradle is also used to hold the Agena tug in the orbiter payload bay; i. e., to serve as the mechanical interface between the Agena (with payload) and the orbiter attach and tiedown fittings.

Objective: To prove the load-carrying ability of the Agena support cradle and propellant tank supporting rings and to measure and determine critical deflections.

Test Specimen: A complete supporting cradle structure, including attach points for:

- Agena tug (and payload, if applicable)
- Orbiter payload bay
- Orbiter deployment (if applicable)

Test Facilities: LMSC Static Test Laboratory.

Test Description: Apply static design and proof loads to attach points simulating worst-case horizontal and vertical acceleration loads with Agena tug and payload during vehicle ground handling and shuttle launch, flight, and landing.

Test Data Required:

- Measured strains under design loads
- Strains and permanent deformations under proof loads
- Failure modes
- Analysis relating cradle deformation under load to Agena structural requirements

- Analysis relating cradle deformation under load to orbiter supporting structure
- Analysis relating orbiter structural elasticity and supporting attach points to measured cradle elasticity and possible constraints

Disposition of Test Article: TBD (destructive test of test specimen).

5.4 AGENA TUG STRUCTURAL DEFORMATION TEST

Situation: The Agena tug application requires that the Agena be handled and moved in both horizontal and vertical positions after alignment, installation of payload, and propellant loading. This handling includes loading into the orbiter payload bay in the horizontal position and subsequent erection of the orbiter and mating of the orbiter with the booster. Although during these operations and later while installed in the payload bay the Agena will be supported by a vehicle-supporting cradle and special ring supports to the propellant tanks, these operations will expose the Agena to loads and deflections different from those encountered in previous Agena operations.

Objective: To determine structural deflections of a fully loaded Agena supported by a cradle and ability to carry loads without adverse deformations or adverse effect on component connections while the Agena/cradle assembly is rotated horizontally and hoisted into a payload bay. Also, to determine effect on Agena vehicle alignments by such handling.

Test Specimen: Vehicle-supporting cradle and an Agena tug vehicle structure with all critical alignment components installed and with simulated loads representing a fully loaded Agena tug with both propellants and payload.

Test Facilities: A mockup of the orbiter payload bay; a simulated orbiter erection mechanism; a crane for lifting the Agena tug into the orbiter mockup; strain gage instrumentation and vehicle alignment equipment.

Test Description: With the Agena properly aligned and instrumented for load and deflection measurements, the operational sequences shall be performed for handling a

loaded Agena from a vertical position to horizontal and for installing the Agena into an orbiter and erecting the orbiter. Following each test, vehicle alignments shall be checked.

Test Data Required: Observed accelerations on the Agena (direction and magnitude) shall be recorded. Strains on critical components and connections shall be determined. Alignment changes shall be measured. Analysis shall relate observed data to effect on Agena performance. Procedures used and developed during the test shall be related to projected shuttle and Agena tug handling and countdown procedures.

5.5 RF DATA TEST

Situation: The Agena tug communications system (Fig. 2-2) must be compatible with unified S-band. The receiver-demodulator performs three functions in the operation of the Agena communications system:

- Amplification of PRN range code
- Coherent drive to the transmitter
- Demodulation of the 70-kHz command subcarrier

The receiver-demodulator incorporates a coherent phase-lock receiver with a $221/8$ received-to-transmitted drive ratio. The input signal is accepted by the RF converter, where it is mixed down to approximately 48 MHz, amplified, and fed to the IF amplifier-mixer module. Here it is mixed again, producing a constant-frequency output of 12.25 MHz. The narrowband phase detector compares the phase of the IF signal and a 12.25-MHz reference signal from the reference generator. The detected phase error is applied as a correction voltage to the voltage-controlled oscillator (VCO), which operates at a nominal frequency of $2 f_1$. (It is this VCO frequency that is adjusted to be compatible with the unified S-band uplink.) The phase-shifted output of the VCO is multiplied in the frequency synthesizer. One output of the frequency synthesizer provides the $216 f_1$ frequency for the RF converter, which mixes with the $221 f_1$ on the RF input to produce a $5 f_1$ output. Another output of the frequency synthesizer goes to the reference generator, where the $10 f_1$ signal is mixed and divided by two with the $2 f_2$ to provide a $5 f_1 + f_2$ to the IF amplifier-mixer module. The third output provides the $8 f_1$ coherent drive to the transmitter.

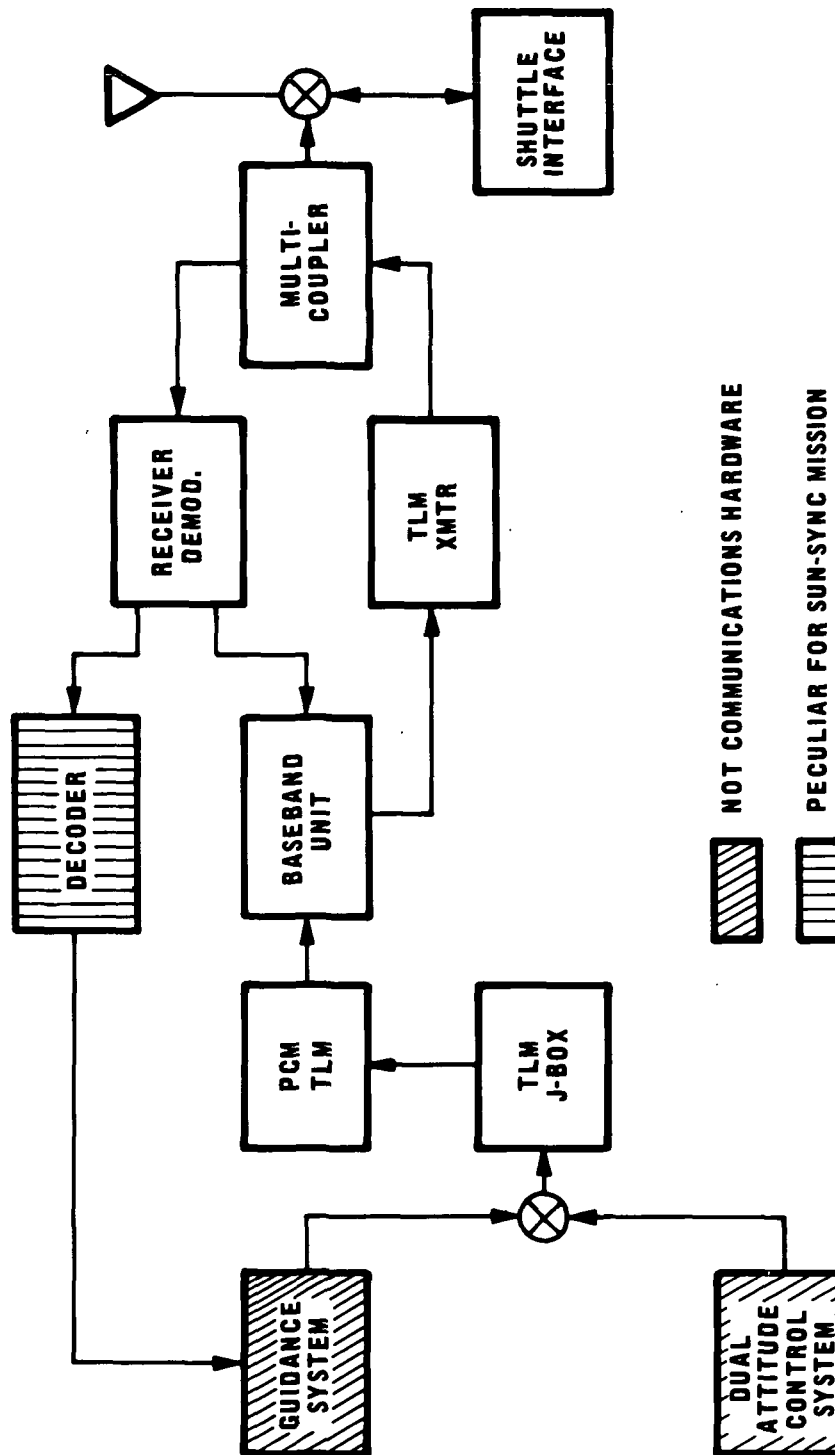


Fig. 2-2 Agena Tug Communications System

Objective: To verify functional compatibility of the Agena communications system RF data equipment.

Test Specimen: Circuit consisting of receiver-demodulator, baseband assembly unit, and transmitter.

Test Facilities: Test and checkout facilities at equipment vendor (probably Motorola).

Test Description: Verify that the receiver will lock on the uplink carrier and that the transmitter is driven coherently by the uplink signal.

Test Data Required: Data and analysis showing that the transmitter operates at its specified center frequency when no uplink carrier is being received. When the receiver captures the unmodulated uplink carrier, it shall be shown that the frequency of the receiver carrier shall shift to TBD frequency and shall be phase coherent with the uplink.

5.6 COMMAND SYSTEM TEST

Situation: The Agena tug application requires that the Agena communications system be compatible with unified S-band GSE. One of the functions of the receiver-demodulator is to receive the uplink signal and demodulate the 70-kHz command subcarrier. The decoder receives the composite signal from the receiver containing the sub-bit information and synchronization and coherently demodulates the signal. It is then detected in a matched filter.

Objective: To verify satisfactory functional operation and compatibility of the command system components of the Agena tug communications system.

Test Specimen: Receiver-demodulator (70 kHz) and command decoder.

Test Facilities: Laboratories of receiver-demodulator vendor or LMSC test laboratories.

Test Description: Send uplink digital command. Verify receiver-decoder compatibility, successful signal decoding, and command execution.

Test Data Required: Data and analysis showing proper functioning under operational commanding conditions. The command system shall respond to all functional commands in accord with the LMSC Command Requirements document. It shall be shown that the command system shall accept and execute commands at the specified rate, shall reject improper commands, shall have the specified sensitivity, and shall phase-lock on the specified uplink command signal.

5.7 INTEGRATED INERTIAL GUIDANCE SYSTEM/DUAL ATTITUDE CONTROL SYSTEM TESTS

Situation: The ascent guidance system (AGS) is primarily an ascent system, and two of the three Agena tug missions are essentially ascent missions. The AGS is, therefore, directly applicable. However, for the long-duration, multi-orbit low-earth-orbit mission, the AGS power requirements are too high. By combining the AGS with a second system, such as the dual attitude control system (DACS), and by adding a command capability to turn the AGS on and off, a system such as DACS can provide attitude control at low power levels over any long coast period. An AGS/DACS combination is shown in Fig. 2-3. The high-accuracy AGS can be used during powered flight and short coasts. During long periods of a mission, the alternate system such as DACS can be used and the AGS turned off. Part of the usual DACS would be deleted under this combined concept. Several components, such as thrust valves, are common to both systems. Some components, such as the telemetry system and electronics assembly, will be modified to be compatible with both systems.

The present DACS exposure time at the launch base is limited to 38 days, and the DACS high-pressure exposure time is limited to 15 days. This will require reexamination, modification, and possibly supporting tests to meet Agena tug requirements.

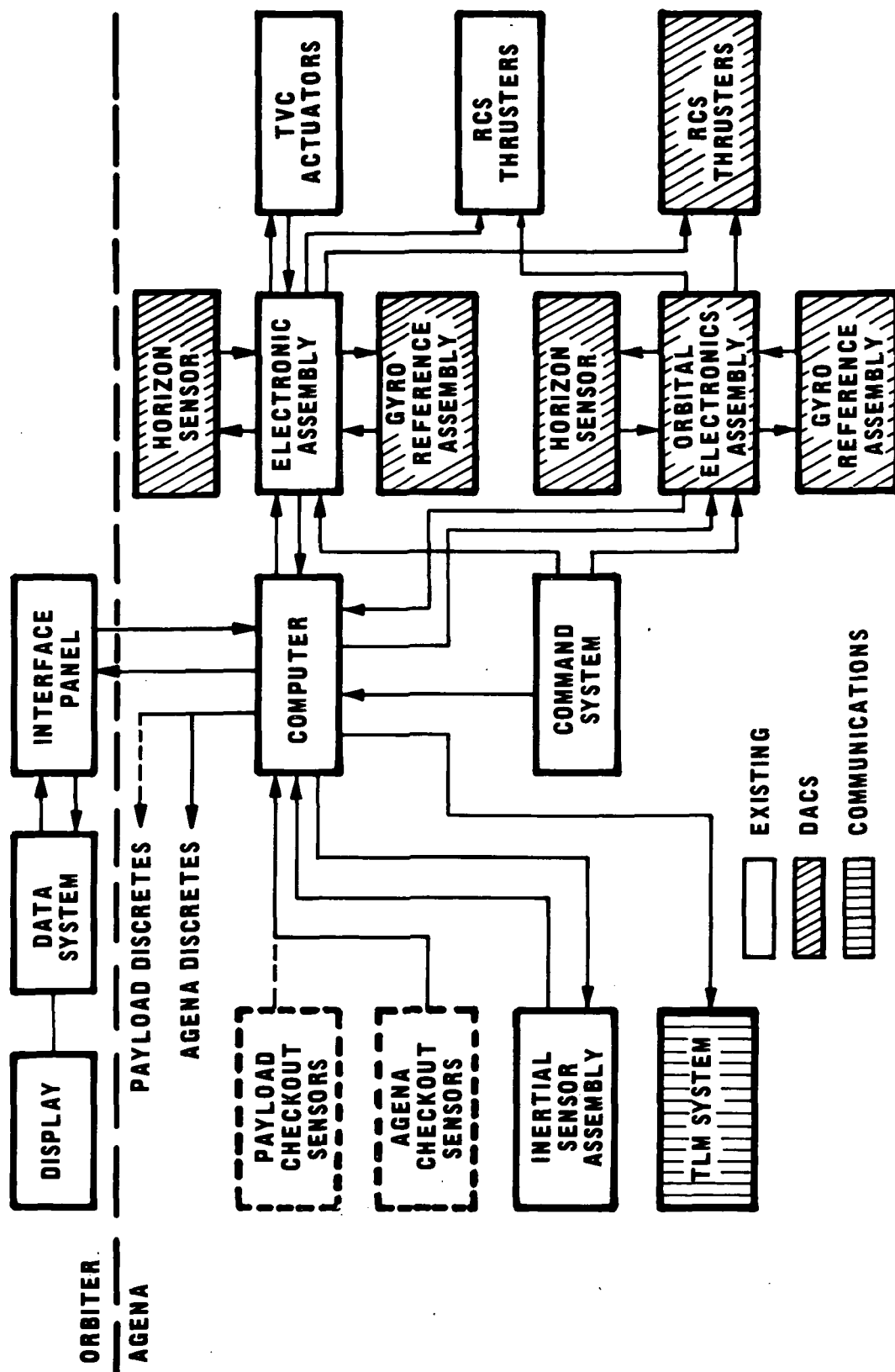


Fig. 2-3 Agena Tug AGS/DACS Schematic

Objectives: To investigate the mission requirements for a combined system of attitude control similar to or the same as the proposed integrated AGS/DACS. To develop system requirements and select a final system design approach. To develop the required flight control electronic interfaces and demonstrate electronic compatibility between AGS and DACS components. To develop AGS on/off switching capability. To demonstrate that performance of the combined guidance system, including ability to satisfy allowable exposure times, meets projected Agena tug mission and operational requirements. To develop an integrated test program (ITP) for the integrated guidance system.

Test Specimen: A development test unit combining into an integrated guidance system AGS and DACS components, including the following:

| <u>Component</u> | <u>Part No.</u> |
|--------------------------------|-----------------|
| AGS: | |
| Inertial Sensor Assembly | LMSC 1460976 |
| Guidance Computer | LMSC 1460977 |
| DACs: | |
| Gyro Reference Assembly | LMSC 1464439 |
| Horizon Sensor | LMSC 1464440 |
| Orbital Electronics Assembly | LMSC 1387591 |
| Augmented Electronics Assembly | LMSC 1387593 |
| Telemetry System | LMSC 1462182 |
| Command System (GFE) | |
| Minimum Command System | GFE 7638725 |
| Readout Decoder | GFE 7642204 |

Development of the test specimen will include development of necessary telemetry and command system interfaces.

Test Facilities: LMSC and guidance system subcontractor laboratories, systems test facilities, and an ITP modified for the combined AGS/DACS guidance system.

Test Description: Develop and test necessary interfaces and design changes. Develop a modified ITP for subsystems and system test checkout.

The present AGS ITP contains 114 tests. Of these, 86 command discretely "on" or "off." Ten of the 28 "true" tests have capability for specifying test parameters (e.g., test duration, gyro torquing rates, etc.) via typewriter at time of test. A data tape, similar to the Flight Program Constants Tape, provides capability to change simulated flight sequences, flight control parameters, geographic constants, and inertial sensor assembly (ISA) compensation parameters without altering the basic program.

Develop a test program similar to the ITP but integrated with the flight program so that it can be used for guidance system final check before separating the Agena from the orbiter in flight.

With the ITP, demonstrate and evaluate the performance of the integrated AGS/DACS subsystems by end-to-end tests of the guidance system.

NOTE

The AGS/DACS ITP shall be discretely automated rather than a single automatic test sequence. It shall be used not only for end to end tests but also for detailed subsystem checks. (Changes in test area setup or vehicle orientation may be desirable between tests.) It shall be used to do a preliminary evaluation of the data from one test before proceeding to the next. It shall also be used for troubleshooting.

The AGS and the DACS portions of the combined system shall be exercised separately. It shall be demonstrated that switching the AGS on and off will not cause the guidance system to malfunction.

Expose required components of the combined guidance system to simulated Agena environments which may cause imposition of exposure limitations inconsistent with Agena tug operational and mission requirements. Determine actions required to meet Agena tug requirements and check results of changes made.

Data Required: Test data, analysis, and report to show that the combined AGS/DACS will meet Agena tug mission requirements. Data shall be provided to verify that the flight control electronics interfaces between DACS and AGS components are compatible. Performance specifications shall be developed to define qualification and acceptance requirements. Equipment specifications with supporting test data shall validate required exposure limitations. An ITP and programming and data for an integrated guidance system flight program checkout tape shall be furnished.

5.8 INERTIAL GUIDANCE SYSTEM (IGS) ACOUSTIC TEST*

Situation: The Agena tug shall be mounted on an Agena vehicle-supporting cradle and enclosed in the orbiter payload bay with payload bay doors closed during shuttle pre-launch, launch, and flight until Agena deployment on orbit. The Agena shall be removed and deployed from the orbiter during an on-orbit coast period. After separation from the orbiter, the Agena shall proceed under its own thrust to mission objectives. The Agena inertial guidance system (IGS) shall be activated during the shuttle prelaunch phase after installation of the Agena in the orbiter payload bay and shall remain active during prelaunch, launch, shuttle flight, deployment, and as required for the Agena flight.

Objective: To check the performance and determine the survival of the IGS under acoustical environments under prelaunch, launch, and flight conditions unique to the Agena tug as carried in the orbiter payload bay. Also, to determine IGS operational characteristics, check IGS gyro drift error compensation by the software, and develop IGS performance parameters for the Agena tug application.

Test Specimen: IGS development test units, calibrated and mounted as indicated below.

Test Facilities and Configuration: The tests will be performed in the Acoustic Test Cell of the LMSC Large Vehicle Environmental Test Laboratory, Sunnyvale, California. The test IGS will be installed in an Agena tug development test unit which shall simulate the Agena tug flight configuration including skins, doors, mounting brackets and plates,

*A using program is currently requalifying the IGS to higher acoustic levels approximately equal to the shuttle requirements. Therefore, this test may not be required.

simulated rack components and with cooling air, plumbing, and the wire harnesses as required for the test. Vehicle system components not required to operate during the test may be either real or mass simulated. An automatic data set shall be used to program the IGS guidance computer, monitor and record IGS operations, and functionally check the IGS before and after each acoustic test.

The Agena tug test unit shall be mounted in an Agena vehicle-supporting cradle and the entire assembly supported in a manner to simulate projected flight acoustic response.

Test Description: The test assembly with IGS shall be exposed to various predicted acoustical environments with the IGS functioning and the computer loaded with the Honeywell acceptance test alignment and acceptance test navigation programs. Inertial sensor assembly constants and geographical input data will be on a tape supplied by the LMSC Attitude Stability and Control System organization after completion of ISA calibrations. Note: This development test can be coordinated with the IGS Agena tug qualification test program.

Test Data Required: IGS performance data shall be recorded before, during, and after each acoustic exposure. The acoustic environmental shape used during each test shall be recorded. Pre- and post-test optical measurements shall be made to determine any specimen movement due to structural or mounting location shifting. The IGS data shall be recorded on magnetic tape. Printouts from the automatic data set shall be obtained. Microphone and accelerometer data analysis will include power spectral density (PSD) and cross power spectral density (CSD) plots. Analysis will relate IGS performance to projected acoustical environmental exposure and to Agena tug guidance requirements.

5.9 PROPELLANT MANAGEMENT SYSTEM MODEL TESTS

Situation: The propellant management system consists primarily of propellant sumps located at the bottom ends of the fuel and oxidizer tanks. The propellant containment capabilities of these sumps provide sufficient quantities of oriented propellants to ensure engine ignition, thus eliminating the need for the ullage orientation rockets. These devices also increase mission performance capability by providing improved propellant scavenging by lowering amounts of non-impulse propellant residuals carried.

The Agena tug propulsion system must fulfill the requirements of three baseline missions:

- I Geosynchronous (three burns or less)
- II Interplanetary (one burn)
- III Low Earth Orbit (six burns)

The present propulsion system basically fulfills requirements of the interplanetary mission.

The synchronous-equatorial mission has a second-burn requirement of 6 sec. If the propellants are deoriented (located in the forward part of the tank), it is possible that propellant sumps would not refill sufficiently during this short second burn to guarantee a third-burn operation. Whether the sump is refilled sufficiently for third burn must be analyzed. If analysis shows insufficient sump refilling, resizing of the sump screens and/or incorporation of passive propellant retention baffles may be required.

The low-earth-orbit mission requires third, fourth, and fifth burns of 12, 6 and 18 sec duration, respectively. If a 5000-lb payload is used, analysis may show that the sumps are refilled sufficiently for each successive burn operation. However, future payloads up to 43,000 lb are envisioned for this mission. With maximum payload, the acceleration during the third, fourth, and fifth burns would be less than 1/3 g. This low acceleration is not sufficient to adequately refill the propellant sumps during these short burns if the tank propellants are not covering the sump inlet screens at time of ignition (i. e., propellants are deoriented forward). If it is assumed that deceleration drag will be sufficient to deorient the propellants, resizing of the sump screens and/or incorporation of passive propellant retention baffles will be required.

Objective: To develop operational parameters in order to assure satisfactory performance of the propellant management system under three representative mission environments.

Test Configuration: Design and fabricate scale models of proposed propellant management system for the multistart Agena tug propulsion system.

Test Facilities and Support: Santa Clara University laboratories and technical assistance under direction of LMSC Engineering staff.

Test Description: Analyze and develop a matrix of requirements, design and fabricate system scale model, conduct 1-g bench tests, conduct low-g drop tower tests, measure and determine system performance relative to given mission environments.

Test Data Required: Test data shall be recorded and the proposed propellant management system shall be analyzed to develop specifications and design requirements. Sump and strainer proposed designs shall be verified. Analysis shall relate expected performance to representative Agena tug mission profiles as specified. Any possible operating constraints shall be identified.

5.10 SAFETY OF PRESSURIZATION STORAGE SYSTEM

Situation: The present nitrogen and helium pressurization tanks have insufficient gas storage volume at pressures 50 percent under burst pressure, which is the maximum allowable for manned vehicle safety requirements. The tank storage system will require one of the following revisions:

- Larger tanks at lower working pressures
- Increased strength of existing tanks
- A multiplicity of existing tanks at lower working pressures with corresponding plumbing changes

Objective: To select and test a revised pressurization storage system and demonstrate that man-safety and performance requirements are met.

Test Specimen: Revised pressurization system as specified on TBD drawing; tanks for burst tests (if applicable).

NOTE

Except for tank burst tests, this development test requirement can be coordinated with development tests of the pressure regulation system.

Test Facilities: Source of hydrostatic pressure and also high-pressure helium and nitrogen: LMSC laboratories.

Test Description: Functional pressurization of the revised system. New or revised components (such as pressurization tanks, if applicable) shall be demonstrated as to strength by burst tests of TBD number of samples at not less than 200 percent of maximum operating pressures. Each new or revised design shall be demonstrated by bursting samples with hydrostatic (water) pressure and then samples with the appropriate helium or gaseous nitrogen.

Test Data Required: Temperature and time history of pressure applications and burst pressures achieved.

5.11 MODIFIED PROPELLANT ISOLATION VALVE (PIV) PRESSURE DROP AND SEALING TEST

Situation: Stringent sealing requirements are presently imposed on the propellant isolation valves (PIVs) which normally:

- Are opened to fill the propellant tanks
- Prevent propellant flow from tanks to engine prior to engine operation
- Connect the propellant tanks to the engine propellant inlet lines during engine operation
- Vent the propellants in the engine following engine operation

The present PIV design does not permit pressure to be applied to the inlet ports after the PIVs are closed if that pressure would break the lip seal. In addition to the normal PIV operating requirements enumerated above, in the Agena tug application new requirements are imposed upon the PIVs and connecting hardware which require investigation, analysis, and possible design modification. These new requirements include the following:

- PIVs will be used as emergency propellant dump valves, dumping through the inlet ports.

- PIV vent lines must be closed off during Agena storage after propellant loading and while the Agena is installed in the orbiter payload bay.

NOTE

Conceivably, this shutoff feature
could be incorporated in the PIV

- Engine and fill/dump lines must be dried out after propellant loading. This may require helium or nitrogen under pressure for blowing out excess propellant from the engine side of the PIV and later imposition of a vacuum at the inlet port to complete the drying operation.
- Some means of maintaining a small residual pressure at inlet and engine ports after drying must be provided to prevent engine breathing.

Objective: To investigate revised PIV requirements. To determine possible effect of these requirements on the PIV design. To measure and verify performance of modifications to the propellant isolation valves to meet revised requirements imposed by the space tug application of the Agena.

Test Specimen: Propellant isolation valve as specified on TBD drawing.

Test Facilities: Helium gas and propellant pressure and fluid flow equipment in LMSC laboratories; 26 \pm 0.5 VDC PIV actuation current and control.

Test Description: Apply TBD pressure successively to tank port, inlet port, and engine port and determine required internal and external leakages. Apply propellants (fuel and oxidizer at different times) to tank port and measure flow (1) to engine and (2) for dumping. Actuate PIV with 26 VDC under simulated operating conditions and determine times of actuation.

Test Data Required:

- PIV actuation times with TBD propellant pressures applied to tank port
- Internal leakage with TBD helium pressure applied to tank port and valve closed
- External leakage (including vent port) with valve open

- Pressure drop/flow rates with propellant applied at TBD pressure at tank port and flow to (1) engine port and (2) inlet port (for propellant dumping)
- Internal and external leakage during and after application of TBD (propellant dump line leak check) pressure applied to inlet port with PIV closed
- If different from preceding item, internal and external leakage during and after application of TBD (fill-dump line purging pressure for drying) pressure to engine port
- Proof test PIV and record pressures and leakage

5.12 PIV VENT LINE SHUTOFF VALVE TEST

Situation: Installation of the Agena tug in the orbiter payload bay, where propellant venting is not permissible, requires that the propellant vent lines be closed off. Also, it is required that the propellant system to the engine be closed to atmosphere to prevent engine breathing after propellant loading, closing of the PIVs, and drying out of the propellant system. This requires the addition of a vent line shutoff valve which can be commanded open or closed under specified operational conditions.

Objective: To verify performance of shutoff valve added to vent port of propellant isolation valves for Agena tug.

Test Specimen: Qualification test article (Note: It is anticipated that this test can be combined with qualification test since an existing valve design can probably be adapted to this application.)

Test Description: Actuate valve to simulate operational requirements. Apply pressure and determine leakage in closed position.

Test Data Required: Leakage measurements over 4- and 18-day periods under TBD pressures simulating extended Agena storage with propellants and storage in orbiter payload bay. Determination of acceptable time limits after exposure to propellants.

5.13 MULTISTART ENGINE TESTS WITH HDA

Situation: Projected Agena tug missions require the use of the restart engine similar to that flown on the Gemini Agena flights. This engine is basically the Bell Aerospace Company (BAC) Model 8096 engine with the BAC Model 8247 start system replacing the pyrotechnic starter cans. The Model 8247 multiple-start system incorporates start tanks that are charged with fuel and oxidizer on the ground. The propellants are contained in these tanks and in the lines between their respective upstream check valves and downstream gas generator solenoid valves. The remainder of the engine is dry.

To initiate engine start, the gas generator solenoid valves are opened, releasing the pressurized start-tank propellants. During steady-state engine operation, the start tanks are recharged with propellants and are ready for a subsequent engine start.

High-density acid (HDA), which is proposed for the oxidizer to increase the specific impulse for mission requirements, has not been used previously with the multistart engine. Start tank and nozzle modifications may be required. The production capability of the manufacturers of start tanks, bellows, and fill valves require review. New vendors may be required for the gas generator solenoid valves and the check valves. The electronic gate will require modifications to the existing baseline vehicle interface circuitry. Electrical and pressure test consoles (GSE) are not available, and fabrication of two sets is required for start-tank loading and electrical interface checks on the ground while mated.

Some missions have a 30-day life requirement with multistart capability. Engine gearbox lubrication for these conditions will have to be demonstrated in a turbine pump assembly by a simulated mission life test. This would include tests with only a film of lubricant in the gearbox as well as with a relubricating kit similar to that qualified and flown on early Agena flights (1960 to 1962).

Engine and start system wet life limitations will require review. This can be coordinated with Propellant System Exposure Time Limitations development tests for the Agena tug. The Agena tug prelaunch plan calls for engine drying out by vacuum methods after propellant loading and prior to installation of the Agena in the orbiter payload bay. It also calls for the capability to store for 14 days in this dry state after propellant loading, plus an additional 4 days in the shuttle prior to launch.

Objective: To investigate multistart engine changes to meet Agena tug mission requirements, to determine and select components and changes shown to be required, to demonstrate by performance tests and measurements that these revisions are acceptable, and to develop revised engine performance parameters for Agena tug applications.

Test Specimen: Development test multiple restart engine based upon the BAC Model 8096 engine with the BAC Model 8247 start system.

Test Facilities: Bell Aerospace Company engine development and testing facilities as LMSC subcontractor.

Test Description: Develop, assemble, and test the multistart Agena tug engine using HDA and meeting LMSC specified multiple start, performance, and life requirements. Review and demonstrate component and supporting equipment capability to meet operating requirements and production availability. Conduct engine test firings; measure operating and performance characteristics. Conduct flight-worthiness demonstration tests (FWDs).

Test Data Required: Measurements and analysis determining performance characteristics including operating regimes, pressures, temperatures, attitudes, operating life, and radiation. Develop engine rating including thrust levels, specific and total impulses, starts, thrust durations, shutdowns, performance under accelerations, loads, time histories and minimum times between cycles, chamber pressures, propellant flow rates, mixture ratios, service and life capabilities, reproducibility. Define component specifications and availability. Develop service and operating procedures and specifications. Develop specifications and tests to define the engine model and provide a basis for production qualification and acceptance.

5.14 ENGINE AND PROPELLANT SYSTEM EXPOSURE TIME LIMITATION TESTS

Situation: The present Agena engine, main propulsion system (MPS), and hydraulic power package (HPP) are limited to 15 days of propellant exposure prior to launch. These limits require reevaluation and supporting tests to allow 14 days in storage plus 4 days from storage removal to launch after exposure to propellant loading.

The MPS, the hydraulic control system components, any engine pyrotechnics (if applicable), and the start system are qualified for 38 days wet. Projected mission requirements would exceed this slightly. A development demonstration test may be required.

The main engine is qualified for the 42 days vacuum on orbit (vacuum results from PIV venting after each burn); no problems are anticipated. However, all time limitation provisions of these systems and components require reexamination in terms of Agena tug sequences requiring propellant loading, vacuum drying, storage, and countdown/launch/orbital deployment elapsed times, as well as delayed engine restarts due to mission requirements.

Objective: To investigate the effect of Agena tug operational and mission requirements upon existing engine and propellant system exposure time limitations. To test and develop, as required, new exposure time limitations or compensating component changes or operating procedures to meet these Agena tug requirements.

Test Specimen: Engine, HPP, and propulsion system components as required for test.

Test Facilities: LMSC, Bell Aerospace, and/or vendor test laboratories as required.

Test Procedures: Expose required components of the systems to propellants simulating the particular new systems requirements in each case. Determine action required to meet Agena tug specifications and check the results of changes made.

Test Data Required: Changed component specifications and revised subcontractor/vendor guarantees with supporting test report documentation to assure satisfactory performance.

5.15 PRESSURE REGULATION SYSTEM TESTS

Situation: The multistart main propulsion system for the Agena tug applications requires a pressure regulation system (previously flown) instead of the blowdown system which is more frequently used. This pressure regulation system may have certain requirements in addition to those normally imposed by mission-oriented propellant management system requirements. These additional requirements may include:

- Maintenance of a minimal pressure on the tanks during longer storage and prelaunch periods (up to 18 days combined) after propellant loading
- TBD requirements for emergency propellant dumping.

Objective: To check the performance of the modified pressure regulation system to:

- Maintain required residual pressures on fuel and oxidizer tanks during extended storage and handling periods
- Apply required propellant pressures to the tanks during multistart engine operations
- Meet TBD emergency dumping requirements.

Test Specimen: Full-scale operational mockup of the proposed pressure regulation system and tanks.

Test Facilities: LMSC laboratories.

Test Description: Duplicate proposed system operating pressures, times, and measurements.

Test Date Required: Analysis to show that measured test results meet design requirements.

5.16 PROPELLANT DUMP-TIME TEST

Situation: Equipment modifications and operating procedures will permit and safety procedures will require a capability for emergency dumping of propellants (fuel and oxidizer) from a loaded Agena tug while in a vertical position:

- Before transfer and installation in the orbiter
- During any extended Agena storage period after propellant loading
- After installation in the orbiter payload bay and rotation of the orbiter to a vertical attitude

NOTE

No emergency dumping can be accomplished with the Agena in a horizontal position.

There are also to-be-defined requirements for emergency dumping of Agena propellants from the orbiter while in flight.

These emergency dumping provisions will require certain valve-opening and pressurization sequences aboard the Agena tug.

Objective: To determine time requirements and verify sequences and procedures for emergency dumping of propellants (fuel and oxidizer) through the propellant isolation valve inlet ports.

Test Specimen: Complete propellant tanking, pressurization, and control system for the Agena tug.

Test Facilities: Propellant loading GSE at the LMSC Santa Cruz Test Base or at the rocket test facility.

Test Description: With propellants loaded, helium pressurization system pressurized to flight requirements, and PIVs closed, actuate the propellant dump sequence.

Test Data Required:

- a. Verification of proper sequencing of the dump operation
- b. Measurement of dump times
- c. Analysis of dump times for the various anticipated ground and flight conditions based upon observed data.

5.17 PROPELLANT LEAK-DETECTION TESTS

Situation: Instrumentation to detect the presence of propellant, either fuel or oxidizer, that may have leaked into the orbiter payload bay may be divided into two categories:

- That required for leak detection under atmospheric conditions while the Agena is enclosed in the payload bay during preparation for launch and under conditions of a decreasing sensible atmosphere in the bay during ascent
- That required for leak detection under evacuated conditions with the Agena in the payload bay after ascent to on-orbit environments

Leak detection for the first condition can be achieved with sensors similar to a mass spectrometer but smaller in size and simpler in operation. Separate sensors will be required for the UDMH and the IRFNA. This type of sensor is available from American Systems Incorporated and from Leeds and Northrup Company. The system could function during prelaunch and ascent by sampling the payload compartment purging gas as it is vented through an opening in the payload bay door.

Leak detection on orbit will be more difficult since the payload bay doors will be open and the bay evacuated. Analysis and testing is required to devise satisfactory instrumentation for this condition. Catalyst cartridges in the vicinity of points of potential leakage have been suggested. If catalyst cartridges are used, a total of four should be adequate: one each for oxidizer and fuel mounted in the Agena aft rack adjacent to the propellant isolation valves and a second pair mounted in the Agena tug forward rack adjacent to the pyro helium control valve and differential pressure vent valve.

Objective: To develop and determine the performance of sensors for detecting possible UDMH and IRFNA leakage from the Agena while it is in the orbiter payload bay in the vacuum of space.

Test Specimen: Candidate catalyst cartridge sensors or other proposed sensing devices.

Test Facilities: Vacuum chamber for sensor tests.

Test Description: With candidate sensors installed in the evacuated test chamber, introduce minute trace amount of UDMH or IRFNA, whichever is applicable, with amounts and distances from sensor controlled.

Test Data Required: Measurements to determine time response and reliability of the detecting sensor relative to:

- Amount and type of propellant present
- Distance of simulated leak from the sensor

Repeatability of the test and determination of susceptibility to other possible contaminants and to false warnings. Analysis of results obtained relative to any projected sensor installation on the Agena tug or in the orbiter payload bay.

5.18 VACUUM DRYING TEST

Situation: It is required that the engine and the propellant (fuel and oxidizer) fill/dump lines of the Agena tug be dried out after propellants are loaded and the PIVs closed. This new requirement is imposed because the Agena tug must be enclosed in the orbiter payload bay.

The Agena tug Launch Base Test Plan calls for imposition of a vacuum on the fill/dump lines for this drying out operation. Special connections may be required next to the engine propellant pressure sensors to facilitate blowing out the residual propellant (similar to the standard propellant abort procedures) before start of the vacuum drying operation.

Although vacuum drying should not impose any new or unusual conditions on the engine (the propellants are vented overboard in the vacuum of space after each engine firing in normal operations), the drying techniques and time requirements must be determined for ground prelaunch operations under new circumstances with a loaded Agena; and the engine and propellant system must operate satisfactorily afterward without further servicing.

Objective: To verify the feasibility of drying out the propellant fill/dump lines and the Agena engine by vacuum techniques. Also, to:

- Determine the best methods (aspirator, vacuum pumps, etc.)
- Define requirements for the GSE for the drying operation
- Verify the adaptability of existing and/or new Agena components (such as the PIV) to the techniques and procedures proposed

Test Configuration and Facilities: Prototype test article Agena tug with simulated cradle fill/dump connections and orbiter connections (if applicable). Propellant vacuum drying system, propellant tanks, and associated equipment.

Test Description: With engine and fill lines (fuel and oxidizer) wet as if propellants loaded, and with propellant isolation valves closed, develop a procedure and time frame for achieving required propellant system/engine dryness for installing in orbiter payload bay. (See also note below on post-drying engine static firing.)

Test Data Required: Recommended procedure, time requirements, dryness observations of discharge versus time. Recommended final design of GSE for drying. Any unusual or unexpected observations on condition of engine, propellant system, or propellant residuals.

NOTE

Upon completion of this test, the engine and fill lines are in a dry state similar to the situation after an engine shutdown and venting in the vacuum of space. Hence, no adverse or unusual state of engine or fill lines should result from this test.

Disposition of Test Article: Agena suitable for further testing and flight.

NOTE

It is recommended that these tests be completed on a prototype test Agena tug just before an engine static firing test. This will then verify that vacuum drying as proposed will have no unwanted or adverse effects on the engine or related propellant systems.

5.19 AGENA TUG STATIC FIRING TEST

Situation: The tug application of the Agena requires modification of a number of engine and propulsion system components and operating procedures. These include:

- Higher strength or expanded volume of pressurization tanks
- Revision to the pressure regulation system
- Improved oxidizer (high-density acid – HDA) with the multistart engine
- Sump and strainer revisions; revised propellant management system
- Provisions for vent line shutoff
- Revisions to the propellant isolation valves
- Provisions for propellant emergency dump sequences and dumping through the PIV inlet ports
- Engine start-tank revisions
- Provisions for drying out the engine and fill lines after propellant loading
- Movement, handling, and rotation of the Agena from vertical to horizontal and back to vertical after propellant loading
- Multistarting sequences.

Objective: To check out and demonstrate acceptable performance of the Agena tug engine and propulsion system under simulated Agena tug operating conditions by static firing tests.

Test Specimen: Development test model of the Agena tug.

Test Facilities: LMSC Santa Cruz Test Base. Agena tug vehicle-supporting cradle, propellant tank supporting rings, cradle dolly, and crane for lifting a loaded Agena with cradle.

Test Description: Load propellants, handle and rotate Agena, simulating launch base procedures and countdown including simulated installation in orbiter payload bay. With cradle removed, fire Agena engine, following projected Agena tug multistart mission sequences.

Test Data Required: Complete engine performance record, including environmental conditions, starts, thrust level, impulse, durations, temperatures, shutdowns, malfunctions, replacements. An analysis of performance related to projected mission requirements is necessary. Recommended procedures for launch base operations, countdown, and on-orbit operations required.

5.20 SOLAR PANEL DEPLOYMENT TESTS

Objective: To confirm deployment operation of a new solar panel configuration.

NOTE

It is assumed that an existing solar panel configuration will be used and that there is no requirement for solar panel deployment tests. If a revised or new configuration is needed due to a change in requirements, a solar panel development test will be required.

5.21 ORBITER POWER AND DATA BUS SIMULATOR TEST

Situation: To develop and check out Agena-related equipment such as the Agena tug payload control console and the Agena/payload service panel/SIU, a simulator

will be required that will electrically resemble the orbiter power bus, the orbiter data bus, and the shuttle telemetry link.

NOTE

This simulator is required for Agena tug development and for subsequent operational tests and checkout. It is required that it be developed and furnished to LMSC as GFE.

5.22 AGENA INTERFACE SIMULATOR TEST

Situation: An Agena/payload service panel and an Agena payload control console will be installed as orbiter equipment for Agena tug flights. It will be necessary to provide a test set that simulates the Agena tug to check out this installation electrically and electronically before each orbiter flight and before installation of the Agena tug in the payload bay.

Objective: To develop and check out a test set that electrically simulates, to the Agena/payload service panel and through it to the orbiter, an Agena tug installed in the payload bay.

Test Specimen: Development interface simulator test unit.

Test Description: Use projected checkout, countdown, and flight procedures to exercise a Agena tug routine.

Test Data Required: Test data and analysis showing that simulator checks out as required. Recommended operating and servicing procedures.

5.23 AGENA/PAYLOAD SERVICE PANEL FUNCTIONAL DEVELOPMENT TESTS

Situation: All interface connections between the orbiter and the Agena/payload will be concentrated at the Agena/payload service panel (Fig. 2-4) except for the physical

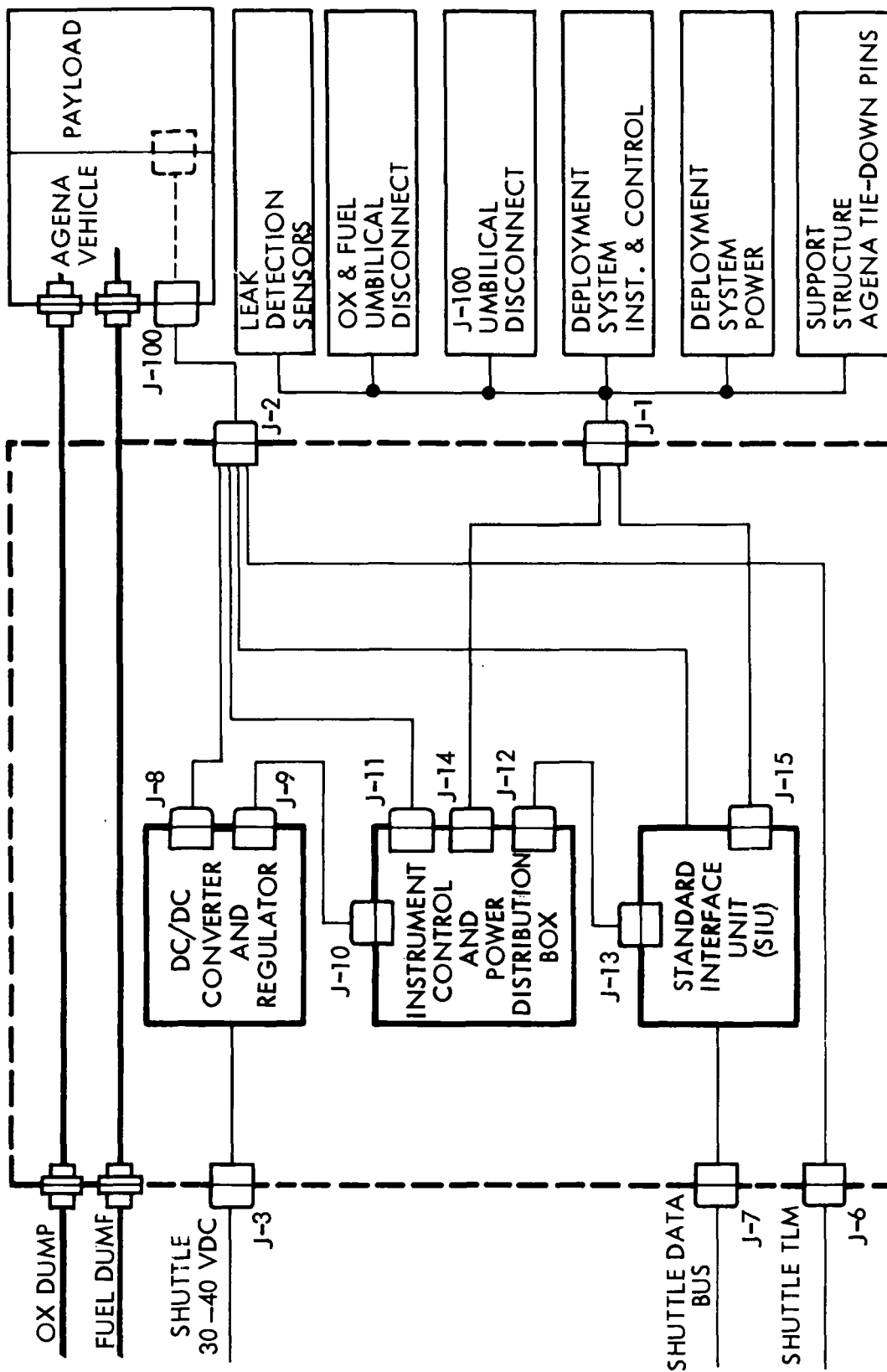


Fig. 2-4 Agena/Payload Service Panel Schematic

support and tiedown of the Agena. The Agena/payload service panel thereby will serve as a junction and distribution box for the various electrical connections between the orbiter and the Agena. The propellant dump lines also will go through the service panel, which will then serve as a coupling point between the fixed, installed pipelines within the orbiter structure and the flexible hoses which connect to the Agena.

The propellant emergency dump lines impose no development problems. However, the various electrical control and conversion units within the Agena/payload service panel remain to be developed.

Objective: To verify the operational characteristics of the Agena/payload service panel to properly convert power and signal characteristics between the orbiter power, telemetry, and payload command systems and the corresponding systems in the Agena tug.

Test Specimen: Complete Agena/payload service panel assembly except for propellant dump line hardware.

Test Facilities and Equipment: Orbiter interface simulator to payload bay; simulated Agena tug command read-in and telemetry readout. Simulated Agena power requirements and monitoring instrumentation.

Test Description: Apply simulated Agena electrical power load to service panel. Transmit simulated Agena commands from orbiter interface simulator and verify command signal output acceptable to the Agena. Apply simulated Agena telemetry signals to Agena side of the service panel and determine that the signal outputs at the orbiter interface are compatible with the requirements of the orbiter data bus and the orbiter telemetry downlink.

Test Data Requirements:

- a. Measure output voltage regulation under conditions of varying Agena power demands and simulated orbiter power input conditions
- b. Determine, record, and verify acceptable command signal output (bit rates, format, power level, modulation, frequency) with simulated command signal input from the orbiter.

- c. Record and verify that telemetry output at the orbiter data bus interface is compatible with the orbiter data bus requirements
- d. Record and verify that the telemetry output from the service panel at the orbiter high-bit-rate telemetry downlink input is compatible with orbiter requirements

5.24 ORBITER PAYLOAD CONTROL CONSOLE FOR AGENA TUG FLIGHTS

Situation: A payload control console unique to Agena tug requirements will be installed in the orbiter at the mission specialist's station. This will be mocked up and its design specified by an earlier development test requirement included in this plan.

Objective: To check and determine performance of the orbiter payload control console.

Test Specimen: Prototype development unit.

Test Facilities: LMSC Agena test facilities and Government or orbiter contractor facilities (GFE).

Test Description: Use the orbiter power and data bus simulator (GFE) and an Agena or Agena simulator connected to an Agena/payload service panel to exercise command checkout and monitoring functions. After successful completion of tests with simulators, assist in checkout with orbiter development mockup or test unit (GFE) at NASA or at the orbiter contractor facility.

Test Data Required: Performance, operating, and recommended servicing data and procedures.

5.25 AGENA SUPPORT/CONSTRAINT SYSTEM RELEASE TESTS

Situation: As presently conceived, the standard orbiter equipment will include a mechanism or device which will remove the Agena tug with payload from the orbiter bay and separate the Agena from the orbiter. This requires two operations in sequence:

1. Release of the latches holding the Agena to the cradle at the instant the payload deployment mechanism of the orbiter starts removing the Agena from the payload bay
2. Release of the Agena from the deployment mechanism after the Agena has cleared the payload bay.

The deployment mechanism is considered standard orbiter equipment. Therefore, tests verifying the second step are orbiter tests exclusively, not an Agena development test requirement, and are not covered in this development plan.

Objective of Test: To verify that the release control and latches which free the Agena tug from the vehicle-supporting cradle release simultaneously and in a manner which does not cause unwanted loads or strains on the Agena.

Test Specimen and Configuration:

- A complete Agena structure or at least that part between and including cradle attach points and deployment mechanism attach points
- A vehicle-supporting cradle
- A simulated orbiter payload controller's console including deployment mechanism controls and Agena latch release controls
- A simulated orbiter payload deployment mechanism.

Test Description: Perform sequences which remove the Agena tug from the payload bay (zero g may be simulated, but will probably not be necessary).

Test Data Required:

- Verify timing and sequencing of various latch release points in relation to each other and to other mechanical functions (such as actuation of deployment mechanism).
- Measure and verify that loads and deflections imposed upon the Agena structure do not exceed permissible limits

5.26 UMBILICAL RELEASE AND RETRACTION TESTS

Situation: The Agena tug will be stored in the payload bay of the orbiter until it is deployed. The Agena propellant fill/dump lines will be connected to the orbiter over-board dump connections in the payload bay through dump line connections at the Agena/payload service panel. When the Agena is deployed, fill/dump line connections must be released through an umbilical release and retraction mechanism.

Objective: To check the performance of the umbilical release and retraction mechanism which is used when the Agena tug separates from the vehicle-supporting cradle during orbital deployment.

Test Specimen:

- Vehicle-supporting cradle with retraction mechanism and ground half of pullaway plugs and quick-disconnects
- Agena with flight half of pullaway plugs and quick-disconnects.

Test Description: Simulate release of the Agena tug from the cradle, duplicating anticipated orbiter payload bay operations and constraints. Verify clean separation of plugs and lines and proper functioning of the retraction mechanism.

NOTE

These tests can be conducted in conjunction with
Agena tug support/constraint system release tests.

Test Data Required: Confirmed performance of the umbilical release and retraction mechanism over a TBD number of simulated deployment operations.

5.27 ORBITAL DEPLOYMENT TESTS

Situation: The tug application of the Agena requires that the Agena be essentially passive (except for the inertial guidance system) in the orbiter payload bay during launch and ascent. The flight plan also calls for the Agena with payload to be deployed from the orbiter while in earth orbit (Fig. 2-5) and to perform its mission independently of the orbiter. The active flight of the Agena tug after deployment is fundamentally the same as for Agena missions carried out over the past decade, and the physical interfaces between the orbiter and Agena tug are minimal. However, it is desirable to carry out shuttle crew operating procedures and to check out the numerous operational and procedural interfaces with the shuttle and between the shuttle and Mission Control during an actual shuttle mission time profile before committing a major payload. Also, since the capability to perform a wide range of payload missions is envisioned for the Agena tug application, this is an opportune time to verify by actual flight experience Agena tug performance with a new combination of Agena subsystem modifications, including:

- Multistart capability with HDA
- Combined ascent guidance system (AGS)/dual attitude control system (DACS) guidance with on/off switching
- Modifications to the tank venting and tank pressurization systems.

Objective: To deploy a development Agena tug during one or more initial shuttle test and training flights to demonstrate operational procedures and compatibility before committing a major payload. A secondary objective is to demonstrate Agena performance with modifications required by the Agena tug application.

Test Specimens: It is recommended that three development test flight units be built:

- One for use in an early unmanned shuttle flight
- One for the first manned shuttle test flight
- One backup unit. (If not used for development tests, this unit becomes a flight vehicle.)

If the success of the first flight(s) precludes the need for subsequent Agena tug test flights, the remaining Agena tugs can be assigned to actual missions.

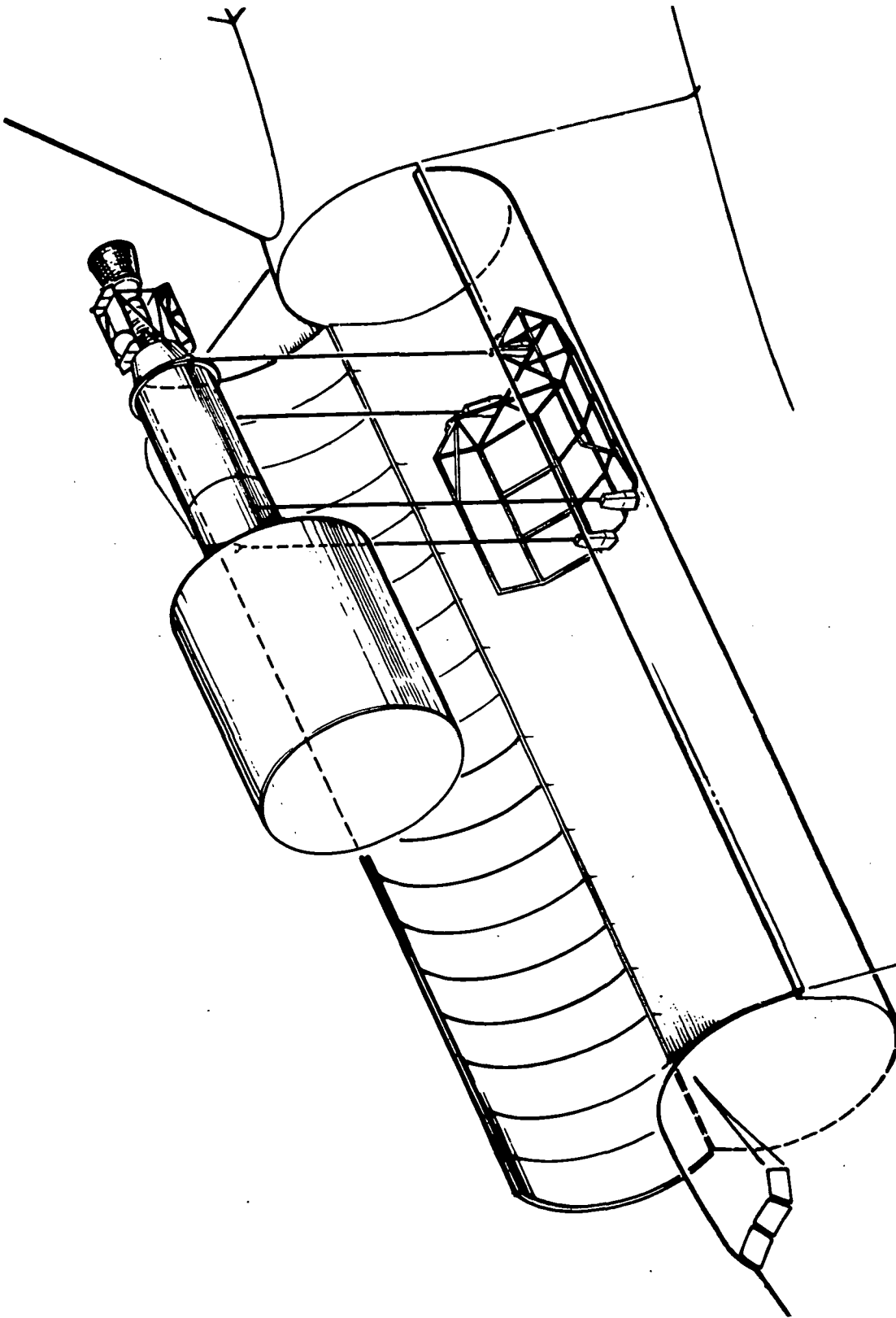


Fig. 2-5 Deployment of Agena Tug With Payload From Orbiter

One test specimen could be a mockup unit with electrical interfaces to be used to exercise predeployment procedures and demonstrate removal from the payload bay. Since this unit need not be actually deployed, it could be returned to earth with the orbiter.

One or more Agena tug development test flight units shall be configured with all recommended standard modifications (multistart engine, revised pressurization and venting systems, etc.) and as many mission-dictated modifications as then available, including the combined AGS/DACS guidance system. A dummy payload may or may not be required.

Test Facilities and Equipment: All Agena tug checkout, launch, and operational facilities and equipment will be required for these tests, including the Agena/payload control console and Agena/payload service panel aboard the orbiter. Two vehicle-supporting cradles and two sets of tank support rings should be available. (These can be used later for shuttle flights and need not be charged to development unless procedures call for deployment of the cradle and/or tank support rings.)

Test Description: On a shuttle orbiter training flight, exercise a complete predeployment flight plan including predeployment checkout of the Agena and perhaps removal from the payload bay. (This could include return to the payload bay and securing for return to earth in the orbiter, depending upon the removal/deployment system used.) Predeployment activities shall include an updating of Agena flight parameters due to a hypothetical perturbation of orbiter orbital injection. If it is decided to commit an Agena to actual deployment and flight, a low-priority payload can be carried.

On at least one flight before a major payload is committed, shuttle and shuttle-earth systems shall be checked out by exercising a complete Agena tug flight plan. The plan for the Agena portion of the flight (after deployment) shall be a composite of the most complex anticipated mission profiles including the maximum number of engine restarts and the most complex maneuvering and guidance requirements. The ability to command the Agena shall be demonstrated both from the orbiter and from the shuttle Mission Control Ground Station.

Test Data Required: Analysis and documentation of the complete operational history, including prelaunch handling through Agena space flight termination. Report shall include an analysis of Agena performance related to projected missions and operational and procedural recommendations.

Disposition of Test Specimen: Flight articles deployed; no recovery planned.

Section 3
QUALIFICATION TEST PLAN

Section 3
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ABBREVIATIONS

| | |
|------|--|
| ADS | Automatic data set |
| CSD | Cross power spectral density |
| CSE | Chief Systems Engineer |
| DACS | Dual attitude control system |
| EMI | Electromagnetic interference |
| FRDS | Fast-reaction development system |
| GRA | Gyro reference assembly |
| IGS | Inertial guidance system |
| ISA | Inertial sensor assembly |
| LMSC | Lockheed Missiles & Space Company, Inc. |
| PAPR | Product Assurance Program Representative |
| PRE | Program Reliability Engineer |
| PSD | Power spectral density |
| REE | Responsible Equipment Engineer |
| TBD | To be determined |
| VRCC | Vital Records Control Center |

1.0 INTRODUCTION AND SUMMARY

This Qualification Test Plan presents a comprehensive and definitive outline of the planned testing, the test-related documentation, and the test program management control required to qualify the design of the LMSC Agena vehicle equipment for use in the Agena tug program. It primarily defines the test program associated with those equipment designs that must be subjected to environmental testing to establish a fully qualified status. Qualification tests required to qualify new or modified components for use on Agena tug baseline missions are described. Specific environmental tests required for each component are identified. Requirements for the preparation, review, and approval of test reports, procedures, and other documentation to implement and control the test program are included.

1.1 SCOPE AND APPLICATION

The formal qualification tests defined and described in this test plan are designed to demonstrate capability of the equipment to meet the qualification requirements that will be specified in applicable detail specifications. Generally, engineering development and evaluation tests defined and described in the Development Test Plan will be completed prior to the start of the qualification test program. These development tests will be performed on new or modified designs to the extent necessary to advance them to the point where there is reasonable assurance that they will meet the functional and qualification requirements specified herein.

Qualification test requirements applicable to the Agena tug program for previously qualified existing equipment fall into three categories:

1. Equipment developed by other Agena using programs and already fully qualified to levels equaling or exceeding the Agena tug requirements. This equipment does not require further qualification testing.
2. Equipment slightly modified to fulfill special mission requirements, or that requiring selection of new vendors, or that requiring changes in tooling and manufacturing methods. This equipment will be subjected to design reviews by Program Engineering and Reliability to determine the degree of requalification testing necessary for flight status certification.

3. Equipment requiring significant design or manufacturing changes or modifications will require requalification testing.

Items falling into these categories of Agena equipment are listed below.

All electromagnetic interference (EMI) tests required at the vehicle level are for development purposes and will be described in an Interference Control Plan. All EMI tests required at the component level are for qualification purposes and are performed in accordance with the requirements of the respective component detail specifications. Those components requiring EMI testing are identified later in this test plan in Table 3-1.

No reliability tests are proposed. Analysis of development, qualification, and other existing test data is used to demonstrate satisfaction of reliability requirements.

The qualification status of major and functional items of equipment comprising the proposed Agena tug configuration is given below for reference and informational purposes only.

a. Currently Qualified Equipment

- (1) Harness Assemblies (NOTE: Will be qualified by similarity to existing designs.)
- (2) Propellant Tank Assembly (NOTE: Involves slight modifications to existing design; requires no further qualification.)
- (3) Aft Structure
- (4) Nitrogen Fill Valve
- (5) Nitrogen Tank (see par. 3.12)
- (6) Propellant Fill Couplings
- (7) Hydraulic Power Package
- (8) Hydraulic Actuators
- (9) Pneumatic Regulator
- (10) Thrust Valve Clusters
- (11) Propellant Isolation Valves (NOTE: Further study may require design modifications and, hence, requalification.)
- (12) Pressure Transducers (oxidizer and fuel)

- (13) Temperature Sensors (oxidizer and fuel pumps)
 - (14) Aft Control and Instrumentation J-Box
 - (15) Check Valve (Lip Seal Pressure)
 - (16) Divergent Nozzle Kit
 - (17) Feed Bellows
 - (18) Rocket Engine
 - (19) Forward Section Structure
 - (20) Helium Tank (see par. 3.12)
 - (21) Propellant Vent Couplings
 - (22) Helium Fill Valve
 - (23) Power Distribution and Control J-Box
 - (24) Main Electrical Umbilical
 - (25) Temperature Sensor (He)
 - (26) Telemetry J-Box Assembly
 - (27) Telemetry Baseband Assembly
 - (28) Telemeter PCM, Type 4
 - (29) Program Pyro and Monitor J-Box
 - (30) Guidance Computer
 - (31) Inertial Sensor Assembly Structure
 - (32) Gyro Reference Unit (GRA-DACS)
 - (33) Horizon Sensor (DACS)
 - (34) RF Switch, Type 14
 - (35) RF Transmitter S-Band
 - (36) Antenna, Type 28
 - (37) Antenna (Parabolic)
 - (38) RF Multicoupler
 - (39) Receiver/Demodulator
 - (40) Propellant Management System (NOTE: To be qualified by similarity if modifications are required,)
- b. New of Modified Designs Requiring Qualification Tests
- (1) Regulated Pressurization System
 - Propellant Vent Relief Valves
 - Pneumatic Regulator

- (2) Rocket Engine Multistart Kit
 - Gas Generator Solenoid Valve
 - Dual Check Valve
- (3) Power Amplifier
- (4) Flight Control Electronics
- (5) Command Decoder
- (6) Inertial Guidance System (acoustic only)
- (7) Propellant Vent Port Lines Shutoff Valves
- (8) Pressurized Gas Tanks
- c. Support Equipment Requiring Qualification Tests
 - (1) Propellant Dump Lines
 - (2) Propellant Dump Control Valve
 - (3) Vehicle-Support Cradle
 - (4) Agena/Payload Service Panel
 - (5) Safety Instrumentation

1.2 MANAGEMENT AND RESPONSIBILITIES

The LMSC Agena Space Tug Program Office will provide administrative and technical guidance, approve test plans and procedures, control schedules and budget, and be responsible for successful completion of the qualification test program specified in this plan and implemented in accordance with the Fast Reaction Development System Implementation Plan, LMSC/A879628. The Program Office, through the Agena tug Chief Systems Engineer (CSE), will be responsible for overall management of the qualification test program and the planning and performance of tests defined in this plan. The CSE will be responsible for revising this test plan, as necessary, to ensure that it maintains its value as a controlling document.

LMSC Engineering will be technically responsible for all phases of the test program including, but not limited to, approval of the tests and requirements outlined in this test plan, approval of test procedures, evaluation and approval of test results, and review of test reports. The Responsible Equipment Engineer (REE) is responsible for preparation of certificates of qualification. Coordination and establishment of test

planning requirements subsequent to initial release of this plan shall be the responsibility of Program Engineering. All new test planning requirements will be reviewed for validity and impact on the test program by the CSE.

The assigned test agency is responsible for preparing test procedures, performing tests, and preparing data sheets and laboratory test reports.

The Product Assurance organization will provide inspection support and surveillance, monitor all qualification testing, impound inspection records at the completion of qualification testing, and retain certificates of qualification.

The Program Reliability Engineer (PRE) will be responsible for preparing a Reliability Program Plan designed to assure compliance with the reliability requirements of the program. He will approve qualification test procedures, approve test procedure change notices, analyze test reports and supporting data to determine that test results are satisfactory, and approve certificates of qualification.

Subcontractors will be responsible to LMSC as invoked by the subcontract for the assigned test program, preparation of procedures, compliance with LMSC quality assurance provisions, and, upon completion of testing, submission of a qualification report. Subcontractor programs and documentation will be reviewed and approved by LMSC Engineering, Product Assurance, and the LMSC Program Office.

2.0 TEST METHODS

The test methods and environmental exposures currently specified in LMSC General Environmental Specification 6117D are invoked in this test plan. Paragraphs of Specification 6117D referenced herein will be updated to reflect the Agena tug program baseline requirements, or similar specification requirements will be established prior to final release of this test plan. In the final release of this plan, specific requirements and test considerations of the applicable detail specifications based on the general requirements of Specification 6117D or its equivalent will be invoked.

The major objective of this test plan is to demonstrate by environmental testing that all new or modified components meet the qualification requirements applicable to the Agena tug baseline missions. However, qualification status and certification may be established by selectively employing any, all, or a combination of the following methods for satisfying the functional and environmental requirements:

- a. Qualification testing
- b. Analysis of applicable data
- c. Similarity to existing qualified design
- d. Inspection to drawing requirements

The testing summary table in the Test Requirements section of this plan shows the applicability of these methods to the Agena space tug program on the basis of available environmental data.

2.1 APPLICABLE DOCUMENTS

The following documents form a part of this test plan to the extent specified herein. The applicable documents identified below and referenced elsewhere in this plan reflect the test philosophy and requirements that are being implemented on other programs presently employing Agena configurations applicable to the Agena tug. Thus, these documents are listed here for informational purposes only. Equivalent documentation specifying similar requirements will be invoked in the final preparation of the qualification test plan for the Agena tug program vehicles. After final issuance, in the event of any conflict of requirements between this plan and an equipment specification, the equipment specifications shall take precedence.

2.1.1 Governmental Documents

| | |
|-------------|-----------------------------|
| MIL-STD-831 | Preparation of Test Reports |
|-------------|-----------------------------|

2.1.2 Lockheed Missiles & Space Company Documents

| | |
|-------|---|
| 6117D | General Environmental Specification for Equipment of the Agena and Associated Payload |
| (TBD) | Propellant Dump Lines |

| | |
|---------|--------------------------------------|
| (TBD) | Propellant Dump Control Valve |
| (TBD) | Gas Generator Solenoid Valve |
| (TBD) | Dual Check Valve |
| 1420797 | Flight Control Electronics |
| (TBD) | Oxidizer and Fuel Vent Relief Valves |
| (TBD) | Agena Payload Service Panel |
| (TBD) | Power Amplifier |
| (TBD) | Command Decoder |

2.1.3 Drawings

| | |
|---------|---|
| (TBD) | Propellant Tank Sump |
| (TBD) | Vehicle-Supporting Cradle |
| (TBD) | Emergency Propellant Dump System |
| 1389670 | Flight Control Electronics |
| (TBD) | Additional Instrumentation |
| (TBD) | Propellant Vent Port Lines Shutoff Valves |

2.1.4 Other Documents

| | |
|---------|---|
| 1420793 | Interference Control Plan for Agena Tug Program |
| A879628 | Product Assurance Plan for Fast Reaction Development Programs |

2.2 TEST SCHEDULES

Test schedules shall be established within the framework of the Agena space tug test program master schedule, which will be established by the LMSC Agena Space Tug Program Office. Detailed schedules indicating planned test dates will be prepared. Any necessary revisions of the allotted spans or test activities which adversely affect the master schedule will require negotiation between affected organizations and the LMSC program office.

2.3 TEST PROCEDURES

Test procedures are required for all qualification tests and will be prepared by the performing test agency. Qualification test procedures shall contain detailed step-by-step instructions, define test levels, identify test equipment required, state accuracy requirements, and provide test data sheets. The qualification test procedures will be approved by the Responsible Equipment Engineer, Program Reliability Engineer, Program Engineering, and the Chief Systems Engineer.

A separate qualification test procedure is required for each component identified by a detail specification. It will include only those qualification tests required for that particular component.

Subcontractor/vendor test procedures are prepared in accordance with established subcontractor/vendor methods. These will be reviewed for concurrence by LMSC Engineering, Reliability, Quality Assurance program representatives, the CSE, and the Agena Space Tug Program Office.

2.4 QUALITY ASSURANCE

The quality assurance program will be implemented in accordance with the Product Assurance Plan for Fast Reaction Development Programs, Amendment 3, LMSC/A879628, or superseding document and shall provide the following major functions and services to the test program:

- Imposition of the responsibilities and support of the LMSC Quality Assurance organization
- Compliance by vendors and subcontractors with the quality assurance provisions of LMSC product assurance standards as invoked by sub-contract; submission of a qualification report by these agencies upon successful completion of qualification testing; and review and approval of vendor and subcontractor test programs, procedures, and quality assurance provisions by LMSC
- Maintenance of inspection records by the LMSC Product Assurance organization in accord with the Data Recording and Handling section of this plan below

2.5 FAILURE REPORTS AND CORRECTIVE ACTION

The LMSC failure reporting and corrective action system shall be applied during all phases of the test program outlined in this plan. When a failure, out-of-tolerance condition, or other discrepancy is noted during qualification testing at LMSC, testing shall be stopped immediately or at the end of the particular test in the test sequence. The test engineer shall immediately notify the Product Assurance Inspection/Product Assurance program representative (PAPR), who in turn shall notify the CSE, Engineering, Reliability program representatives, and others as appropriate. After careful verification of the discrepant condition, Inspection/PAPR shall record the discrepancy on a discrepancy log. All discrepancies during qualification testing shall be logged completely on the discrepancy log form in accordance with the requirements of LMSC/A879628, Product Assurance Plan for Fast Reaction Development, Amendment 3. The discrepancy log contains the following information as a minimum:

- Test specimen identification
- Complete and accurate description of the discrepant condition
- A comprehensive statement of the action taken to process the discrepancy

A copy of each discrepancy log shall be included as part of the final report.

The methods for failure reporting and corrective action for subcontractor/vendor activities are in accordance with established subcontractor vendor methods. Failure reports are subject to review and concurrence by LMSC Engineering and Product Assurance program representatives. For failures at LMSC or subcontractor facilities, the CSE, Engineering, and Reliability Program representatives are mutually responsible for ensuring that the effect of the failure upon the design is properly evaluated and corrective action measures applied.

2.6 DATA RECORDING AND HANDLING

Permanent records of all test data shall be made and retained. The raw test data will be recorded manually or automatically by suitable means. The recorded raw data will be processed, and the resulting processed data in the form of data sheets, graphs,

plots, or other presentations will become a part of the inspection record packages and test reports. Data sheets of manually recorded raw data also will become part of the inspection record packages and test reports.

The originals of LMSC-generated test data shall be retained by the test agency for a minimum of 6 months. The test agency may then, with concurrence of the program office, transfer the data to the LMSC Vital Records Control Center. Test data shall be retained a minimum of 2 years after contract termination. After 2 years, the test data shall be retained until released by the LMSC Space Tug Program Office.

The originals of subcontractor/vendor-generated test data shall be retained by the subcontractor/vendor a minimum of 2 years after termination of the LMSC contract. The period of data retention shall be specified by the subcontractor/vendor sale contracts.

2.7 TEST REPORTS

Two types of test reports, flash reports and final reports shall formally transmit results of all testing.

- a. Flash Reports. These are prepared by the test agency and issued as a timely means of informing Engineering, the LMSC program office, and Reliability of the technical progress being made on a test assignment. They are issued upon, but not limited to, the following occasions and within the time period specified:
 - (1) Conclusion of a significant test or phase of testing (within 3 days)
 - (2) Failure of a test specimen to perform as required (within 24 hours)
 - (3) Need to explain or document special test program developments (within 3 days)
 - (4) Inability to continue the test program due to material shortages, test equipment breakdown, etc. (within 24 hours)

Flash reports contain a general statement describing the test conducted and the results achieved, as minimum information. Copies of each flash report are sent to the CSE, the Project Leader, Responsible Equipment Engineer, and the Engineering, Reliability, and Product Assurance program representatives.

- b. Final Reports. For each component tested, a formal final report is prepared by the test agency in accordance with the applicable paragraphs of MIL-STD-831 and containing, as a minimum, the following technical information:

- (1) Abstract of the test
- (2) Copies of test procedures used
- (3) Copies of completed data sheets and reduced data
- (4) Discussion and description of the test, including any anomalies which occurred during the testing
- (5) Copy of discrepancy logs

Within 30 days after completion of testing, the final report is submitted to Program Engineering for review and analysis of test results before it is released.

2.8 TECHNICAL CONTROL

Technical control of the testing shall be achieved through design reviews, specification requirements, and review of test procedures and test reports. The following specific measures assure test program technical control:

- a. Adherence to approved specification requirements
- b. Complete and precise definition of test requirements in, and consistency between, approved specifications, test plans, and test procedures
- c. Requirements for Product Assurance to monitor qualification and acceptance testing
- d. Systematic test reporting and evaluation of performance data
- e. Failure reporting system

3.0 TEST REQUIREMENTS

The tests that must be performed to fully qualify the Agena and related support equipment for the Agena tug program baseline missions are defined and described in this section on the basis of available environmental data. These tests are summarized in Table 3-1, which shows in matrix form the equipment to be tested and the applicable

environmental tests that must be performed. If a particular test is not required, the table indicates whether the requirement (1) is met by analysis, by inspection, or by similarity to an existing qualified design, or (2) does not exist as a requirement of the respective component detail specification. This additional information is presented for reference only.

3.1 PROPELLANT DUMP LINES

Objective: To qualify the propellant dump lines for use on the Agena tug program

Test Specimen: One each (oxidizer and fuel) of the qualification test units of the propellant dump lines, LMSC Part No. (TBD)

Test Schedule: (TBD)

Test Description: The dump lines between the Agena tug and the Agena/payload service panel shall be subjected to the environmental tests shown below in accordance with the test methods and exposures defined in LMSC General Environmental Specification 6117D. The dump lines shall be inspected and checked for functional performance before and after exposure to each environmental test. The functional performance shall be as specified in the applicable detail specification. The environmental tests shall be performed in accordance with the referenced paragraphs of LMSC 6117D. The order of performance of the environmental tests is optional.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.1.3.2 |
| High-Vacuum Orbital* | 4.10.1.2 |
| Corrosive Atmosphere | 4.10.7 |
| Leakage | 4.10.1.2.1 |

*This test may be combined with the high temperature-low pressure test.

Table 3-1
COMPONENT QUALIFICATION TEST PROGRAM SUMMARY

| LEGEND | | Design Status | | Test Agency | Qualification Test | | | | | | | | | | | | | | | | | |
|---------------------------------|---------------------------|---------------|-----------------|-----------------|--------------------|--------|-----------|----------------|------------|--------------|---------------------|----------------------|---------------------|---------|----------|----------|-----|-------------------|-----------------|------------|-------------------|--|
| Symbol | Description | New Design | Modified Design | Existing Design | LMSC | Vendor | Vibration | Standard Shock | Pyro Shock | Acceleration | Low Temp-Low Press. | High Temp-Low Press. | High-Vacuum Orbital | Leakage | Humidity | Acoustic | EMI | Fungus Resistance | Corrosive Atmos | Structural | Funct Performance | |
| X | By Test | New Design | | | X | | X | X | | A | | | X | X | | | | | X | | | |
| A | By Analysis | | | | | | X | X | | A | | | X | X | | | | | X | | | |
| S | By Similarity | | | | X | | X | X | X | | A | X | X | X | X | | | X | I | X | | |
| I | By Inspection | | | | X | | X | X | X | | A | X | X | X | X | | | X | | X | | |
| Blank | No Requirement | | | | | | | X | X | | A | X | X | X | X | | | | | | | |
| E | Existing Qualified Design | | | | | | | | | | | | | | | | | | | | | |
| Equipment | | | | | | | | | | | | | | | | | | | | | | |
| Propellant Dump Line | | X | | | X | | X | X | | A | | | X | X | | | | | X | | | |
| Propellant Dump Control Valve | | X | | | | X | X | X | | A | | | X | X | | | | | X | | | |
| Gas Generator Solenoid Valve | | | | X | | X | X | X | | A | X | X | X | X | | | X | I | X | | | |
| Dual Check Valve | | | | X | | X | X | X | | A | X | X | X | X | | | | | X | | | |
| Regulator (Prop. Press. System) | | | | X | | X | X | X | | A | X | X | X | X | | | | | | | | |
| Propellant Tank Sump | | | X | | X | | S | S | | S | S | S | S | | | | | | | | A | |
| Propellant Vent Relief Valve | | | | X | | X | X | X | | A | X | X | X | X | | | | | | | X | |
| Vehicle-Supporting Cradle | | X | | | X | | X | X | | A | X | X | X | | | A | X | I | | X | | |
| Agena/Payload Service Panel | | X | | | X | | X | X | | A | X | X | X | | X | A | X | I | | | | |
| Power Amplifier | | X | | | | X | X | X | X | A | X | X | X | | X | A | X | I | | | | |
| Flight Control Electronics | | | X | | X | | X | X | S | S | X | X | X | | S | X | X | I | | | | |
| Command Decoder | | | X | | | X | X | X | X | A | X | X | X | | X | A | X | I | | | | |
| Inertial Guidance System | | | | X | | X | E | E | E | E | E | E | E | | E | X | E | E | | | | |
| Electronic Gate (Multistart) | | | | X | | X | E | E | E | E | E | E | E | | | A | E | E | | | | |
| Emergency Prop. Dump System | | X | | | X | | A | A | | A | A | A | A | | | | | | | | A | |
| Safety Instrumentation | | X | | | | X | X | X | | X | X | X | X | | X | X | X | I | X | | | |
| Pressurized Gas Tanks | | X | | | | X | X | X | A | A | | | | X | | A | | | | | | |
| Vent Port Lines Shutoff Valve | | X | | | | X | X | X | | A | X | X | X | X | X | A | X | I | X | | | |

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

Disposition of Test Specimen: Upon completion of all qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control purposes.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California

3.2 PROPELLANT DUMP CONTROL VALVE

Objective: To qualify the propellant dump control valve for use on the Agena tug program

Test Specimen: One qualification test unit of the propellant dump control valve, LMSC Part No. (TBD)

Test Schedule: (TBD)

Test Description: If a propellant dump valve is required for installation in the payload bay, it will be a new design and shall be subjected to the environmental tests shown below. The tests shall be performed in accordance with the test methods and exposures defined in the referenced paragraphs of LMSC 6117D and as specified in the dump valve detail specification. The valve shall be inspected and functionally tested to the requirements of its detail specification before, during*, and after exposure to each environmental condition. The order of performance of the environmental tests is optional.

*As applicable

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.1.3.2 |
| High-Vacuum Orbital* | 4.10.1.2 |
| Corrosive Atmosphere | 4.10.7 |
| Leakage | 4.10.1.2.1 |

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

Disposition of Test Specimen: Upon completion of all qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control purposes.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California

3.3 GAS GENERATOR SOLENOID VALVE

Objective: To qualify the gas generator solenoid valve for use on the Agena tug program

Test Specimen: One qualification test unit of the gas generator solenoid valve, LMSC Part No. (TBD)

Test Schedule: (TBD)

* This test may be combined with the high temperature-low pressure test.

Test Description: The gas generator valve is a previously qualified design but, because of the length of time since qualification and the probability of a different supplier employing different tooling and manufacturing methods, requalification testing as described below may be necessary. The environmental tests shall be performed in accordance with the test methods and exposures defined in the referenced paragraphs of LMSC Specification 6117D. The valve shall be inspected and functionally tested before, during*, and after the environmental tests in accordance with the requirements of the detail specification.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.2 |
| High-Vacuum Orbital** | 4.10.1.2 |
| Leakage | 4.10.1.2.1 |
| Corrosive Atmosphere | 4.10.7 |

NOTE

A portion or all of the above specified tests may not be required, depending on engineering assessment of vendor processes and manufacturing methods.

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

*As applicable

**This test may be combined with the high temperature-low pressure test.

Disposition of Test Specimen: Upon completion of all qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control purposes.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California

3.4 REGULATOR (PROPELLANT PRESSURIZATION SYSTEM)

Objective: To qualify the propellant pressurization system regulator for use on the Agena tug program

NOTE

Further study may show that a simpler system utilizing a motor-operated valve may be used. In either event, qualification testing as described below may be required.

Test Specimen: One qualification test unit of the Agena tug propellant pressurization system regulator, LMSC Part No. (TBD). The test specimen shall have been inspected and checked for functional performance in accordance with the requirements of its detail specification prior to the performance of any environmental qualification test.

Test Schedule: (TBD)

Test Description: The regulator is an existing previously qualified design but, due to the length of time since qualification, requalification testing as specified below may be required. However, a portion or all of these tests may not be required, depending upon engineering assessment of vendor processes and manufacturing methods. The environmental tests shall be performed in accordance with the test methods and exposures (unless otherwise modified by the applicable detail specification) defined in the referenced paragraphs of LMSC Specification 6117D.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|--|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.2 |
| High-Vacuum Orbital* | 4.10.1.2 |
| Leakage | 4.10.1.2.1 |
| EMI (motor-operated valve system only) | 4.10.12 |

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

Disposition of Test Specimen: Upon completion of all qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control purposes.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California

3.5 OXIDIZER AND FUEL VENT RELIEF VALVES

Objective: To qualify the oxidizer and fuel vent relief valves for use on the Agena tug program

Test Specimen: One each of the qualification test units of the oxidizer and fuel vent relief valves, LMSC Part No. (TBD)

*This test may be combined with the high temperature-low pressure test.

Test Schedule: (TBD)

Test Description: The oxidizer and fuel vent relief valves are an existing qualified design but, due to the length of time since qualification, different tooling and manufacturing methods may be required, thereby necessitating requalification testing as specified below. (NOTE: A portion or all of these tests may not be required, depending on engineering assessment of vendor processes and manufacturing methods.) The tests shall be performed in accordance with the test methods and exposures defined in the referenced paragraphs of LMSC Specification 6117D. The valves shall be inspected and functional performance verified in accordance with the requirements of the applicable detail specification before, during*, and after the environmental tests.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.2 |
| High-Vacuum Orbital** | 4.10.1.2 |
| Leakage | 4.10.1.2.1 |

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

Disposition of Test Specimen: Upon completion of all qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control purposes.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California

*As applicable

**This test may be combined with the high temperature-low pressure test.

3.6 VEHICLE-SUPPORTING CRADLE

Objective: To qualify the vehicle-supporting cradle for use on the Agena tug mission applications

Test Specimen: One qualification test unit of the vehicle-supporting cradle, LMSC Part No. (TBD)

Test Schedule: (TBD)

Test Description: The cradle will be qualified by structural, performance, and environmental testing as specified below:

- a. Structural Test. The cradle will be supported and mounted in a test setup that simulates the attachment, loading, and support conditions imposed by the shuttle/Agena/payload interfaces. Two static load tests will be performed for each of two selected critical loading conditions. During the first test for each of the two critical conditions, the static loading will be slowly applied until 100 percent of the design limit load is reached. It will then be reduced to zero for the purpose of detecting yield. The test will then be repeated, using the design ultimate limit (150 percent design limit load) as the upper limit. The method selected for introducing load into the structure (load fixture configuration) shall be approved by Program Engineering. Deflections shall be measured relative to rigid reference support points. Strain and deflection measurements at critical points shall be taken for each applied load.
- b. Performance Tests. The Agena payload attachment means shall be checked for holding and release capability while loaded with simulated Agena payload loading conditions. The tests shall be performed prior to and subsequent to the 100 percent design limit load tests described above. Instrumentation shall be checked for range, sensitivity, and accuracy requirements.
- c. Environmental Tests. The cradle shall be subjected to the environmental tests listed below. For the vibration and standard shock tests, the cradle will be supported and loaded in a manner simulating flight conditions. Proper operation of the release mechanisms shall be verified during the temperature-pressure tests and high-vacuum orbital tests, and before and after the vibration and shock tests. The test methods and exposures shall be as specified in the cradle specification and shall be similar to those specified in the referenced paragraphs of LMSC 6117D, which are provided here for information only.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|--------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure* | 4.10.1.3.1 |
| High Temperature-Low Pressure* | 4.10.1.3.2 |
| High-Vacuum Orbital* | 4.10.1.2 |
| EMI* | 4.10.12 |

Test Data Required: Data to verify that the required environments have been correctly applied and to describe the functional performance of the specimen. The data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6. The test data shall include still photographs of the structural test setup, strain, deflections, and applied loads, plotted as functions of percent design limit loads.

Test Specimen Disposition: Upon completion of the qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control and use in systems testing.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California.

3.7 AGENA/PAYLOAD SERVICE PANEL

Objective: To qualify the Agena/payload service panel for use on the Agena tug program

Test Specimen: One qualification test unit of the Agena/payload service panel, LMSC Part No. (TBD)

Test Schedule: (TBD)

*These tests may be performed at the subassembly level; i.e., on representative samples of instrumentation and the release and attachment mechanisms.

Test Description: The qualification unit shall be checked for functional performance and to the environmental requirements listed below. The functional tests shall include verification of the electrical and mechanical interface requirements with the shuttle and the Agena. Data transmission, electrical power conversion and distribution, command transmission, instrumentation conditioning, and mechanical fit and function will be verified. The functional tests shall be performed in accordance with the requirements specified in the detail specification. The service panel shall then be subjected to the environmental tests listed below. The tests shall be performed in accordance with the test methods and exposures specified in the referenced paragraphs of LMSC Specification 6117D. Functional performance requirements to the extent specified in the detail specification shall be verified before, during, and after each environmental exposure.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.2 |
| High-Vacuum Orbital* | 4.10.1.2 |
| Electrical Interference | 4.10.12 |
| Humidity | 4.10.1.3 |

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

Disposition of Test Specimen: Upon completion of all qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control purposes.

*This test may be combined with the high temperature-low pressure test.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California

3.8 POWER AMPLIFIER

Objective: To qualify the power amplifier for use on the Agena tug program

Test Specimen: One qualification test unit of the power amplifier, LMSC Part No. (TBD)

Test Schedule: (TBD)

Test Description: The qualification unit shall be checked for functional performance and to the environmental requirements listed below. The functional tests shall be performed in accordance with the requirements specified in the applicable detail specification. The environmental tests shall be performed in accordance with the test methods and exposures specified in the referenced paragraphs of LMSC Specification 6117D as invoked by the detail specification. Functional performance requirements shall be verified before, during*, and after each environmental exposure.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.2 |
| High-Vacuum Orbital** | 4.10.1.2 |
| Leakage | 4.10.1.2.1 |
| Humidity | 4.10.1.3 |
| Electrical Interference | 4.10.12 |

*As applicable

**This test may be combined with the high temperature-low pressure test.

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

Disposition of Test Specimen: Upon completion of all qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control purposes.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California

3.9 COMMAND DECODER

Objective: To qualify the command decoder for use on the Agena tug program

Test Specimen: One qualification test unit of the command decoder, LMSC Part No. (TBD)

Test Schedule: (TBD)

Test Description: The qualification test unit shall be checked for functional performance and to the environmental requirements listed below. The functional tests shall be performed in accordance with the requirements specified in the applicable detail specification. The environmental tests shall be performed in accordance with the test methods and environmental exposures specified in the referenced paragraphs of LMSC 6117D except as modified by the applicable detail specification.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.2 |
| High-Vacuum Orbital* | 4.10.1.2 |
| Humidity | 4.10.1.3 |
| Electrical Interference | 4.10.12 |

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

Disposition of Test Specimen: Upon completion of all qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control purposes.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California

3.10 INERTIAL GUIDANCE SYSTEM (ACOUSTIC)

Objective: To evaluate the inertial guidance system (IGS) performance and survival under acoustic environments imposed by Agena tug applications, to evaluate the IGS software compensation for gyro drift error induced by acoustic environments, and to provide sufficient information on IGS operation in the acoustic environment to satisfy equipment qualification requirements. NOTE: The IGS is qualified to levels equal to or exceeding those imposed by the Agena tug program for all environments except acoustic.

*This test may be combined with the high temperature-low pressure test.

Test Specimen:

- a. IGS development test units
- b. Agena development test unit
- c. Vehicle-supporting cradle

Test Facilities: This qualification test will be performed by the LMSC Large Vehicle Environmental Test Laboratory (D76-30) in an acoustic test cell at Building 156C, Sunnyvale, California.

Test Schedule: (TBD)

Configuration: The IGS will be installed in an Agena development test unit which shall be configured as for flight, including the IGS development test components, skins, mounting brackets and plates, simulated rack components, cooling air distribution system, plumbing, and the wire harnesses required for the test. Vehicle system components not required to operate during the test may be either real or mass-simulated. The IGS shall be connected to the automatic data set, which shall be used to program the IGS guidance computer, monitor and record IGS operations, and functionally check the IGS before and after each acoustic test.

Specimen Mounting: The Agena shall be attached to a vehicle-supporting cradle and supported in a manner simulating actual flight conditions. The tanks shall be filled with water to provide a more closely simulated flight acoustic response. Means shall be provided to limit extraneous and floor/wall transmitted vibrations.

Specimen Orientation: The test specimen shall be oriented so that the vehicle +X axis will be within 3 degrees of vertical and the -Z axis within 6 degrees of true north.

Instrumentation:

- a. Microphones. Pickups will be installed in and around the test specimen. At least three of the pickups shall be mounted inside the rack; the remainder will be externally suspended in the vicinity of the specimen. Exact locations will be specified by Aero-Mechanics, O/62-62. The pickup used shall be approved by O/62-62.

b. Accelerometers. Endevco (or equivalent) accelerometers shall be installed on the specimen as follows:

- (1) At various locations on the ISA support structure
- (2) At various locations within the rack

Exact locations and detailed mounting instructions for the accelerometers will be supplied by Aero-Mechanics, O/62-62 (Loads and Structural Dynamics).

Test Program: The test program will be conducted in two phases. In the first, the test will be performed at a simulated flight environment to establish a baseline or reference level. The second test will be at the qualification level, which is 3 dB higher than the flight level. The exact overall levels and acoustic profiles will be supplied by the LMSC Aero-Mechanics organization (O/62-62).

Software: The computer will be loaded via a test tape (AGENACAL) furnished by Honeywell. The tape will include the Honeywell acceptance test alignment program and an acceptance test navigation program. ISA constants and geographical input data will be on a tape supplied by O/62-11 (Attitude Stability and Control Systems) and will be punched immediately after completion of ISA calibrations.

Test Data Requirements: IGS performance data before, during, and after each acoustic exposure; the acoustic environmental shape used during each test, and pre- and post-test optical measurements to determine any specimen movement due to structural or mounting location shifting

The IGS data, in the form of AGS-2 recordings on magnetic tape, shall be supplied to O/62-11 (Guidance and Flight Mechanics) for reduction and analysis. Printouts from the automatic data set (ADS) shall be made available in real time.

Microphone and accelerometer data reduction requirements will be specified by Aero-Mechanics, O/62-62, and will include power spectral density (PSD) and cross power spectral density (CSD) plots.

Disposition of Test Specimen: Instructions for disposition of the test specimen shall be provided by Agena tug program Engineering upon completion of the qualification tests.

3.11 SAFETY INSTRUMENTATION

Objective: To qualify special instrumentation that must be provided to satisfy safety monitoring requirements that arise due to the presence of a fueled and flight-ready Agena in the cargo bay of the shuttle.

Test Specimen: The special instrumentation will include, as a minimum, the following measurements:

- a. Fuel and oxidizer tank temperatures
- b. Fuel and oxidizer tank pressure
- c. Oxidizer tank to fuel tank differential pressure
- d. Cargo bay temperature
- e. Detection of fuel/oxidizer leakage into cargo bay

The temperature and pressure measurements can be provided by selection from designs currently used by other programs; hence, no further qualification testing is required. Means for detection of propellant leakage into the cargo bay are not presently defined, but possible candidates may be the use of a sensor similar in character to a small, simplified mass spectrometer during periods when there is a sensible atmosphere in the cargo bay and the use of a catalyst-type cartridge when the cargo bay is subjected to vacuum conditions. Both types of sensors will need qualification testing. Representative production samples shall be used as the qualification test units.

The propellant fuel and oxidizer tanks will require slight modifications to permit attachment of the pressure probes. Other additional instrumentation to be provided for special vehicle health monitoring will be selected from presently qualified designs.

Test Schedule: (TBD)

Test Description. The qualification test units shall be subjected to the tests specified below unless otherwise specified in the detail specifications. The environmental tests shall be performed in accordance with test methods and exposures similar to the requirements specified in the referenced paragraphs of LMSC 6117D. Performance shall be demonstrated to the requirements of the applicable individual detail specification before, during, and after the environmental tests.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Acceleration | 4.10.9 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.2 |
| High-Vacuum Orbital* | 4.10.1.2 |
| Corrosive Atmosphere | 4.10.7 |
| Humidity | 4.10.1.3 |
| Acoustic | 4.10.11 |
| EMI | 4.10.12 |

Disposition of Test Specimen: Unless otherwise directed by Program Engineering, the test specimen shall be retained by the vendor for processing as nonflight items for control purposes.

Test Facilities: Vendor-designated test laboratory, approved by LMSC

3.12 PRESSURIZED GAS TANKS

Objective: Because of Agena tug program man-safety considerations, it is possible that a redesign of the Agena vehicle pressurized gas tanks may be required. However,

*This test may be combined with the high temperature-low pressure test.

it is anticipated that further study will show that the nitrogen and helium gas loading requirements may be satisfied by presently qualified designs. If either one or both of the tank designs must be qualified by test, the test program shall be as specified below.

Test Specimen: Two each of the qualification test units of the guidance system nitrogen tanks, LMSC Part No. (TBD) and the propulsion pressurization system helium tank, LMSC Part No. (TBD)

Test Schedules: (TBD)

Test Description: Each test unit shall be subjected to performance and environmental tests in accordance with the requirements specified in the applicable detail specification and the test methods and exposures defined in LMSC Specification 6117D. The tests shall include those listed below and shall be performed in a manner similar to that described in the referenced paragraphs of LMSC Specification 1417281.

| <u>Test</u> | <u>Specification 1417281 Par. No.</u> |
|---------------------------------------|---------------------------------------|
| Preproduction (Qualification) Testing | 4.5 |
| Cleanliness Verification | 4.4.2.4 b |
| Vibration | 4.4.3.1 |
| Standard Shock | 4.4.3.2 |
| Proof Pressure | 4.4.2.1 |
| Leakage | 4.4.2.2 |
| Temperature Monitor | 4.4.2.3 |
| Life Test | 4.4.4 |
| Extended Life Test | 4.4.5 |
| Burst Pressure (First unit) | 4.4.6 |
| Burst Pressure (Second unit) | 4.4.7 |

Test Data Required: Data to verify that the required environments have been correctly applied and that all functional performance requirements as specified in the detail specification have been satisfied. The functional performance for the tanks shall include cleanliness, leakage, proof pressure, and burst pressures.

Disposition of Test Specimen: The test specimen shall be retained by the vendor for disposition unless otherwise directed by Agena tug program engineering.

Test Facilities: The tests shall be performed by the tank supplier or a designated test laboratory approved by LMSC.

3.13 PROPELLANT VENT PORT LINES SHUTOFF VALVE

Objective: To qualify the design of the propellant vent port lines shutoff valves for use on the Agena tug program

Test Specimen: One each (oxidizer and fuel) of the qualification test units of the propellant vent port line shutoff valves, LMSC Part No. (TBD)

Test Schedule: (TBD)

Test Facilities: Test laboratory designated by supplier and approved by LMSC

Test Description: The shutoff valves are a new design and will require the qualification testing specified below. The tests shall be performed using test methods and environmental exposures similar to those defined in the referenced paragraphs of LMSC 6117D and as specified in the valve detail specification. The test valves shall be inspected and functionally tested to the requirements of their detail specification before and after the environmental tests. The order of performance of the environmental tests is optional.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.1 |
| High-Vacuum Orbital* | 4.10.1.2 |
| Corrosive Atmosphere | 4.10.7 |
| Leakage | 4.10.1.2.1 |
| Humidity | 4.10.1.3 |
| EMI | 4.10.12 |

*This test may be combined with high temperature-low pressure test.

Test Data Required: Data to verify that the required environments have been correctly applied and that the functional performance meets specification requirements. The data shall be prepared and submitted in flash and final reports in conformance with par. 2.7. All raw data shall be retained by the test agency in conformance with par. 2.6.

Disposition of Test Specimen: Unless otherwise directed by Program Engineering, test specimen shall be retained by the supplier and processed as nonflight items.

3.14 DUAL CHECK VALVE

Objective: To qualify the dual check valve for use on the Agena tug program

Test Specimen: One qualification test unit of the dual check valve, LMSC Part No. (TBD)

Test Schedule: (TBD)

Test Description: The dual check valve is a previously qualified design but, because of the length of time since qualification and the probability of a different supplier employing different tooling and manufacturing methods, requalification testing as described below may be necessary. The environmental tests shall be performed in accordance with the test methods and exposures defined in the referenced paragraphs of LMSC Specification 6117D. The valve shall be inspected and functionally tested before, during*, and after the environmental tests in accordance with the requirements of the detail specification.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.8.1 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.2 |
| High-Vacuum Orbital** | 4.10.1.2 |
| Leakage | 4.10.1.2.1 |
| Corrosive Atmosphere | 4.10.7 |

*As applicable

**This test may be combined with the high temperature-low pressure test.

NOTE

A portion or all of the above specified tests may not be required, depending on engineering assessment of vendor processes and manufacturing methods.

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

Disposition of Test Specimen: The test specimen shall be retained by the vendor for disposition unless otherwise directed by Agena tug program engineering.

Test Facilities: The tests shall be performed by the valve supplier or a designated test laboratory approved by LMSC.

3.15 FLIGHT CONTROL ELECTRONICS

Objective: To qualify the electronics unit for the flight control system for use on the Agena tug program

Test Specimen: One qualification test unit of the flight control electronics, LMSC Part No. (TBD)

Test Schedule: (TBD)

Test Description: The basic flight control electronic unit will require redesign and modification in order to be compatible with and a controlling element for both the inertial guidance system and the dual attitude control system. Although the basic circuitry and design configuration are flight-qualified, the modified design will be subjected to the qualification tests listed below. The environmental exposures and test methods shall be as defined in the referenced paragraphs of LMSC Specification 6117D. The unit shall be inspected and functionally tested before, during, and after the environmental tests in accordance with the requirements of its detail specification.

| <u>Test</u> | <u>Specification 6117D Par. No.</u> |
|-------------------------------|-------------------------------------|
| Vibration | 4.10.10 |
| Standard Shock | 4.10.9.1 |
| Low Temperature-Low Pressure | 4.10.1.3.1 |
| High Temperature-Low Pressure | 4.10.1.3.2 |
| High-Vacuum Orbital | 4.10.1.2 |
| Acoustic | 4.10.11 |
| EMI | 4.10.12 |

Test Data Required: Data to verify that the required environments have been correctly applied and data to describe functional performance of the test specimen shall be recorded. These data shall be prepared and submitted in flash and final reports in conformance with par. 2.7 of this test plan. All raw test data shall be retained by the test agency in conformance with par. 2.6 of this test plan.

Disposition of Test Specimen: Upon completion of all qualification tests, the test specimen shall be delivered to Program Engineering to be processed as a nonflight item for control purposes.

Test Facilities: Environmental Test Laboratory, Building 102, LMSC, Sunnyvale, California

Section 4
SYSTEM TEST PLAN

Section 4
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|-----|---------------------------------------|-----|

DEFINITION OF TERMS AND ABBREVIATIONS

| | |
|------|--|
| AGS | Ascent guidance system |
| BAC | Bell Aerosystems Company |
| CART | Condition of assembly at release and transfer. CART is the means for transferring responsibility for the vehicle (or other equipment) from Manufacturing to the Vehicle System Test organization. The transfer is implemented with an interdepartmental communication that identifies the condition of the assembly, noting and itemizing any open items relating to the condition of the vehicle and bearing the signature of representatives of the Manufacturing, Vehicle System Test, and Product Assurance organizations. |
| CCA | <p>Configuration controlled article. CCAs are items of equipment that are considered by Engineering and the SSD configuration management system to be of such significance that a specified method of technical tracking and recording requirements in terms of design evolution, test data, quantity, etc., is warranted. The implementation of the method includes unit serializing to provide the following tracking information:</p> <ul style="list-style-type: none">• Accountability of actual hardware quantities• An index of failure, modification, and usage history, and manufacturing and test records• Records for use in scrap policy implementation• Historical data for cost estimating purposes |
| CSE | Chief Systems Engineer |
| DACS | Dual attitude control system |
| EBO | <p>Engineering buyoff. EBO refers to a meeting, chaired by the Chief Systems Engineer (CSE) or his representative, that takes place upon completion of the final system test. Its purpose is to evaluate all open data discrepancies and in general determine the technical acceptability of the vehicle before it and related documentation are submitted to the customer for acceptance review. The meeting is attended by representatives of the following organizations:</p> <ul style="list-style-type: none">a. CSE (chairman)b. Test teamc. Program Engineeringd. System Test Operationse. Product Assurancef. Program Reliabilityg. Customer (at his option) |
| EMC | Electromagnetic compatibility |
| EMI | Electromagnetic interference |
| F/C | Flight Control |
| GCA | Guidance computer assembly |

| | |
|------|---|
| GGPV | Gas generator propellant valve |
| GGSV | Gas generator solenoid valve |
| GRA | Gyro reference assembly |
| HGTU | Hydraulic ground test unit |
| HPP | Hydraulic power package |
| HPTC | High-pressure test cell. This is a facility area, constructed and operated in such a manner as to permit testing and servicing of equipment that imposes special safety considerations because of its design and function. In particular, provisions for high-pressure leak testing and the handling of propellants are included. |
| H/S | Horizon sensor |
| HSA | Horizon sensor assembly |
| IGS | Inertial guidance system |
| ISA | Inertial sensor assembly |
| LBII | Launch base installed items |
| LMSC | Lockheed Missiles & Space Company, Inc. |
| MPL | Master procedures list |
| OMPS | Oxidizer manifold pressure switch |
| PCM | Pulse code modulation |
| PIV | Propellant isolation valve |
| POSV | Pilot-operated solenoid valve |
| PSE | Program support equipment |
| QD | Quick disconnect |
| RF | Radio frequency |
| SPP | Standard Policies & Procedures (LMSC) |
| SSD | Space Systems Division (LMSC) |
| TASC | Temperature-altitude simulation chamber |
| TLM | Telemetry |
| TT&C | Tracking, telemetry, and command subsystem |
| UHF | Ultra high frequency |

1.0 INTRODUCTION

This test plan establishes a projected acceptance test program at the factory for the baseline configuration of the Agena tug. The program defines and limits the acceptance testing activities associated with the vehicle assembly from initial acceptance testing of components and assemblies through integrated systems tests and preparations for shipment to the launch base. The detailed tests set forth represent the total preplanned testing necessary to demonstrate that vehicle performance meets the acceptance requirements established for the Agena tug baseline configurations.

1.1 SCOPE

It is recognized that additional test requirements may result from modifications, replacements, or readjustments of components. Such additional testing will be performed in accordance with revisions to this test plan or special test instructions issued by Program Engineering.

To provide the detail necessary to adequately reflect the scope and projected performance verifications that will be required of Agena tug vehicles, this test plan has incorporated to the maximum extent feasible the test philosophy and requirements presently being implemented on programs employing Agena configurations applicable to the Agena tug.

The applicable documents identified in par. 2.1 and referenced in this plan reflect these programs and are listed herein for informational and references purposes only. Equivalent documentation specifying similar requirements will be invoked in the final test plan for Agena tug vehicles.

To the extent permitted by vehicle design and practicability, end-to-end testing will be the basis for determining adequate vehicle performance during system testing.

This System Test Plan does not control launch base testing nor testing of the shuttle vehicle and the payload, except to demonstrate proper shuttle/Agena and payload/Agena interface requirements.

1.2 TEST VEHICLE CONFIGURATION

The test requirements of this plan are applicable to the Agena space tug basic configuration. Certain additional configuration requirements are imposed by the baseline missions established for the Agena tug. Major requirements in the vehicle configurations for the baseline missions are summarized below for informational and reference purposes.

| Configuration Requirement | Baseline Mission | | |
|--|---------------------|------------------------|--------|
| | Planetary Injection | Synchronous Equatorial | 30 Day |
| Basic Vehicle | X | X | X |
| Multistart Engine (8247) | X | X | X |
| Unified S-Band Communications | X | X | X |
| Command Decoder | X | X | X |
| Flight Control Electronics | X | X | - |
| Nitrogen Tank | X | X | - |
| Additional Status and Checkout Sensors | X | X | - |
| Primary Battery | X | - | - |
| Parabolic Antenna | - | X | - |
| Power Amplifier (RF) | - | X | - |
| Additional Primary Battery | - | X | - |
| Secondary Battery | - | - | X |
| Solar Array | - | - | X |
| Charge Control | - | - | X |
| DACS (or 1/2 DACS) | - | - | X |

Except for addition of the solar array and DACS systems for the 30-day mission, the test program is essentially the same for all three mission configurations. In the text, these exceptions are noted by "as applicable."

2.0 TEST POLICY AND GENERAL PROVISIONS

2.1 APPLICABLE DOCUMENTS

The following non-governmental documents of the latest issue form a part of this System Test Plan to the extent specified herein (see par. 1.1).

2.1.1 LMSC Specifications

| | |
|---------|---|
| 1067084 | Primary Battery, Type IVB |
| 1412961 | Temperature Sensor |
| 1415503 | Pressure Squib |
| 1420763 | UHF Phase Modulated Transmitter, Type 19 |
| 1420764 | Baseband Assembly, Type 2 |
| 1420766 | PCM Telemeter, Type 4 |
| 1420780 | Stage III Vehicle |
| 1420781 | Discrete Control J-Box |
| 1420782 | Power Distributor and Control Box |
| 1420793 | Interference Control Plan |
| 1420797 | Flight Control Electronics Assembly (Ascent Guidance System) |
| 1420799 | Telemetry Junction Box |
| 1420801 | Aft Control and Instrumentation Box |
| 1420818 | Vehicle/AGE Interface |
| 1420821 | Inertial Guidance System |
| 1420837 | Wire Harness Assemblies |

2.1.2 LMSC Drawings

| | |
|---------|---|
| 1374898 | Thermal Resistor Assembly, Temperature Sensor |
| 1389097 | Telemetry J-Box |
| 1389034 | Discrete Control J-Box |
| 1419628 | Detail Specification, Model 72205 Vehicle |
| 1420961 | System Test Specification (Vehicle S/N 2901) |

| | |
|---------|---|
| (TBD) | Agena/Payload Service Panel |
| 1389602 | Vehicle Assembly |
| 1389603 | Launch Base Installed Items |
| 1389613 | Power Distribution and Control Box |
| 1389660 | Aft Control and Instrumentation Box |
| 1389670 | Flight Control Electronics Assembly (Ascent Guidance System) |
| 1389820 | Program Pyro and Monitor J-Box |
| 1460958 | UHF Phase Modulated Transmitter, Type 19 |
| 1460959 | Baseband Assembly, Type 2 |
| 1460965 | PCM Telemeter, Type 4 |
| 1460976 | Inertial Sensor Assembly |
| 1460977 | Guidance Computer |
| 1461693 | Temperature Sensor |
| 1462071 | RF Switch, Type 14 |
| 1462090 | Primary Battery, Type IVB |
| 1464036 | Pressure Transducer |

2.1.3 Other Documents

| | |
|-------------|--|
| M30000-XXXX | Master Procedure Lists (Manufacturing) |
| S40000-XXXX | Master Procedure Lists (Vehicle System Test) |

2.2 SAFETY

LMSC Safety and Industrial Hygiene Standards shall be enforced during all testing activities. Application of pneumatic pressures to the vehicle pneumatic systems shall be in accordance with LMSC Safety Standard 5.6E (Unfired Pressure Vessels and Systems).

2.3 SCHEDULE

A typical schedule for factory tests (manufacturing and system tests) applicable to the Agena tug is shown in Fig. 4-1. This preliminary schedule is for planning purposes; it will be superseded by the vehicle master schedule, when applicable.

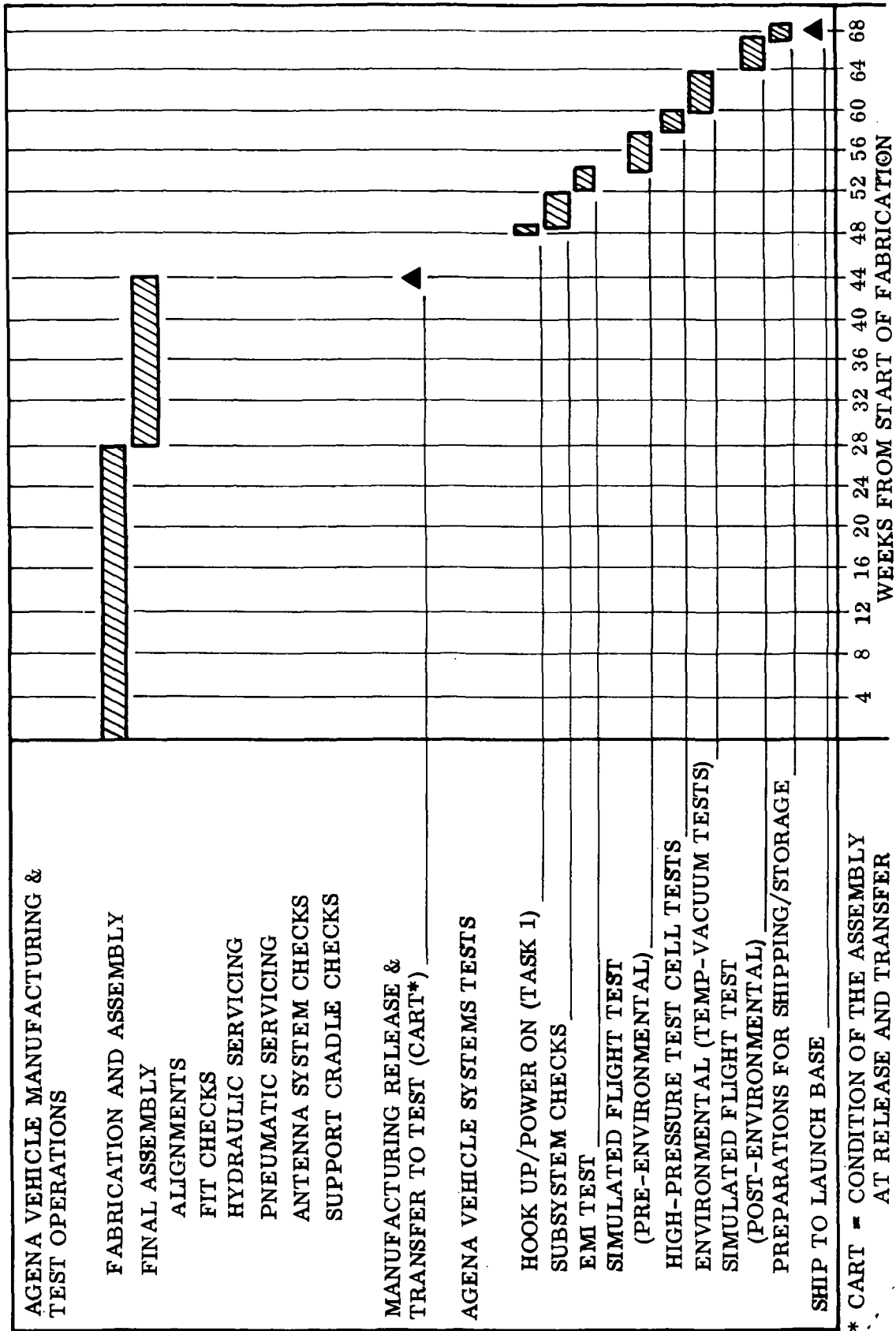


Fig. 4-1 Agena Tug Factory-to-Launch Base Tests

2.4 NON-LMSC COMPONENTS

All vendor-supplied components shall be acceptance tested by the vendor in accordance with the LMSC specifications indicated herein. Vendor testing is subject to witnessing by LMSC Supplier Product Assurance and shall follow the guidelines of LMSC/SSD Procedure Q-506.

Final acceptance of vendor-supplied components will be made at LMSC by Receiving Inspection. Unless otherwise noted, receiving inspection will take place at Sunnyvale and shall be limited to inspection for identification and damage. In certain cases, as specified herein, LMSC shall repeat certain testing performed by the vendor. All vendor-supplied components and the number of all test procedures required to implement LMSC acceptance testing of any of these components shall be listed in TDR 11-580, Supplier Equipment Inspection and Test Criteria Control List.

A copy of all calibration records generated during receiving and inspection shall be transmitted to the LMSC Test Data/Analysis organization for incorporation in the vehicle calibration book. Data from testing performed by vendors may be used to supplement, or in lieu of, data from testing performed by LMSC.

2.4.1 Vendor-Supplied Components

Vendor-supplied components and their applicable detail acceptance specifications will include the following:

| <u>Component</u> | <u>Applicable LMSC Specification</u> |
|------------------------|--|
| Sensor, Temperature | 1412961 |
| Gas Storage Tank | 1417281 |
| Battery, Type 1H | 1418601 |
| Battery, Type VIA | 1410550 |
| Battery, Type IVB | 1067084 |
| PCM Telemeter, Type IV | 1420766 |
| Command Decoder | TBD |

| | |
|--|---------|
| Baseband Assembly | 1420953 |
| Transmitter (2 watt) | 1419277 |
| Power Amplifier | (TBD) |
| Multicoupler, Type 14 | 1419745 |
| RF Switch, Type 14 | 1419552 |
| Receiver, UHF-PM | 1416750 |
| Inertial Guidance System | 1420821 |
| Inertial Sensor Assembly | 1420821 |
| Guidance Computer | 1420821 |
| Gyro Reference Unit (DACS) | 1421008 |
| Orbital Electronics Assembly (DACS) | 1420831 |
| Horizon Sensor (DACS) | 1419268 |
| Propellant Fill Coupling | 1067287 |
| Pneumatic Check Valve | 1420158 |
| Thrust Valve Clusters | 1420741 |
| Fuel Feed Bellows | 1420654 |
| Oxidizer Feed Bellows | 1421029 |
| Fuel and Oxidizer Fill Bellows | 1420654 |
| Pressure Transducer (Pump Inlet) | 1416604 |
| Pressure Transducer (Combustion Chamber) | 1416616 |

2.4.2 GFE Components

The GFE components and the applicable detail specifications that define their acceptance test requirements will include the following, which are presented herein for documentation and reference purposes only.

| <u>Component</u> | <u>Applicable Specification</u> |
|---------------------------|---------------------------------|
| Hydraulic Servo Actuators | 1067289 |
| Nitrogen Tank | 1412816 |
| Hydraulic Power Package | 1412975 |
| Nitrogen Regulator | 1414273 |
| Squib, Pressure (M-11) | 1415503 |

| | |
|--|---------------------|
| Propellant Isolation Valve | 1415273 |
| Temperature Probes (Oxidizer and Fuel) | 1410060 |
| Liquid-Propellant Rocket Engine (modified to Model 8247 multiple start) | BAC 8096-475300-35* |

2.5 QUALITY ASSURANCE PROVISIONS

2.5.1 Quality Control

Quality Control shall monitor testing, certify compliance with approved test procedures as posted in the vehicle log book, and verify compliance with the Quality Assurance provisions of the Agena tug/OOS Detail Model Specification. Quality Assurance provisions shall comply with the following listed LMSC SSD standard policies and procedures (SPP). (This is not intended to be a complete listing, but represents important applicable SSD policies and procedures):

- a. O-107 Vehicle Testing
- b. E-235 Limited Calendar Life Items, Control of
- c. E-236 Limited/Controlled Operating Life Items, Control of
- d. Q-305 Acceptance, Vehicle or Product

2.5.2 Operations

The testing program established by this System Test Plan and the test requirements imposed by the detail specification shall be implemented in accordance with SSD operating procedures, as defined by the following listed SPPs. (This is not intended to be a complete listing, but represents important applicable SSD policies and procedures):

- a. E-233 Connector Mating Control, Vehicle (Plug Lists)
- b. M-504 Flight Instrumentation, Calibration of and Verification Checks of
- c. O-151 Log Books, Vehicle, After Final Assembly
- d. O-201 Documentation of Vehicle Launch Preparation
- e. O-314 Test Aids and Auxiliary Test Equipment

*Vendor part number

2.5.3 Equipment Reset

Upon completion of any vehicle system test, the vehicle assembly equipment shall be reset to the state necessary to preclude equipment damage during subsequent testing or upon reapplication of power. The reset will include, but not be limited to, the following:

- a. Computer reset
- b. Rocket engine in the shutdown mode

2.5.4 Retest

When components, modules, sections, or assemblies are replaced, repaired, or modified to correct failures experienced during testing specified by this test plan. to incorporate design changes subsequent to testing affecting these items, or to update the vehicle after periods of storage, the requirements for retesting shall be established by the CSE, or by Engineering with the approval of the CSE. When a repair, replacement, or modification has been effected and testing has progressed to the system level, the intent of the retest shall be to verify the integrity of all reconnections, repaired/replaced equipment, and affected systems. Such repairs, replacements, and/or modifications effected subsequent to performance of the environmental system tests (par. 3.2.3) shall not constitute a requirement to repeat all or any portion of the environmental system tests.

2.5.5 Prelaunch Time Limitations

The time limitations applicable to the vehicle assembly complete kit shall be as established in Section 6 of the Vehicle Service and Flight-Readiness document.

3.0 FACTORY AND ACCEPTANCE TEST PROGRAM

The required detail tests (manufacturing and system tests) and the engineering documents which establish the criteria and limits for these tests are specified in this section. Applicable procedures for accomplishing the tests shall be prepared by the responsible

test agencies and will be listed in master procedure lists (MPLs). Applicable MPL drawing numbers for this test plan are M30000-XXXX and S40000-XXXX; they are prepared by Manufacturing and System Test, respectively. The Manufacturing MPL will include the tests performed on LMSC-manufactured components, as well as those performed during subassembly and final assembly operations. Vendor-supplied and GFE components are to be considered separately in the supplier equipment inspection and test criteria control list prepared by the LMSC Test and Inspection Engineering organization.

3.1 LMSC MANUFACTURING TEST PROGRAM

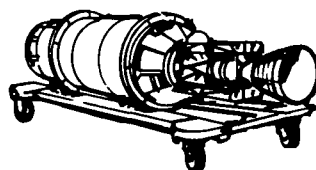
Acceptance testing of all components manufactured by LMSC and all testing of sections, modules, and subassemblies of the vehicle complete kit (program assembled Agena) shall be performed prior to CART of the vehicle complete kit. Numbers of all test procedures required to implement component and vehicle complete kit testing (pars. 3.1.1 and 3.1.2 below, respectively) shall be listed in MPL M30000-XXXX.

3.1.1 LMSC-Manufactured Components

All components, manufactured or modified and reidentified by LMSC Manufacturing, shall be tested in accordance with the applicable LMSC specification and shall include the components listed below. Testing shall be performed before they are installed in the vehicle. Each test shall be witnessed and certified by LMSC Product Assurance (Reference: LMSC SSD Policy Q-506). A copy of all calibration records generated during Manufacturing testing shall be transmitted to the LMSC Data Reduction/Analysis organization for incorporation in the vehicle calibration book.

| <u>Component</u> | <u>Applicable LMSC Specification Stock</u> |
|--------------------------|--|
| Charge Controller | (TBD) |
| Power Distribution J-Box | 1420782 |
| Solar Array | (TBD) |
| Telemetry J-Box | 1420836 |
| Antenna, Type 28 | 1420990 |
| Command Decoder | (TBD) |

| | |
|-------------------------------------|---------------|
| Parabolic Antenna | (TBD) |
| Aft Control and Instrumentation Box | 1420801 |
| Flight Control Electronics | 1420797 |
| Orbital Electronics Assembly (DACs) | 1420831 |
| Thermal Resistor Assembly | (Dwg 1374898) |
| Wire Harness Assemblies | 1420837 |
| Gas Fill Coupling | 1419693 |
| Propellant Tank Assembly | 1414819 |
| Agna/Payload Service Panel | (TBD) |

**AGENA FINAL ASSEMBLY**

3.1.2 Vehicle Assembly Manufacturing Tests

The following operations and acceptance tests shall be performed on the vehicle assembly by the Final Assembly and Vehicle Modification organization.

3.1.2.1 Propulsion System High-Pressure Side Pressurization. The helium system monitor tool shall be installed, the propulsion system high-pressure side (upstream of the the pyro-operated helium valve) pressurized, and the pressure maintained thereafter in accordance with the following paragraph of LMSC Specification 1420780, Part II:

5.1.2.3.1.1.2c (Vehicle Assembly Pressurization Helium Tank)

3.1.2.2 Propulsion System Low-Pressure Side Pressurization. The propulsion system monitor tool shall be installed, the propulsion system low-pressure side (downstream of the pyro-operated helium valve) pressurized, and the pressure maintained thereafter in accordance with the following paragraph of LMSC Specification 1420780, Part II:

5.1.2.3.1.1.2b (Vehicle Assembly Pressurization Propulsion System)

3.1.2.3 Pneumatic Attitude Control System Pressurization. The pneumatic attitude control system nitrogen tanks shall be pressurized and the pressure maintained thereafter in accordance with the following paragraphs of LMSC Specification 1420780, Part II:

4.4.7a (Gas Contamination)

4.4.7b (System Pressurization)

3.1.2.4 Hydraulic Attitude Control System Servicing. The hydraulic system shall be filled, checked for cleanliness, checked for leakage, and functionally tested in accordance with the following paragraphs of LMSC Specification 1420780, Part II:

4.4.6 (a through d) (Hydraulic Attitude Control Systems Tests)

4.4.6.1 (Hydraulic System Cleanliness)

4.4.6.2.1 (HPP Over-Fill Valve Tests)

4.4.6.3 (Hydraulic System External Leakage Checks)

3.1.2.5 Vehicle Weight and CG Determination. By analysis, the weight and CG of the vehicle complete kit, consisting of the vehicle assembly and launch base installed items (LBII) shall be determined. The vehicle assembly shall be weighed for CG separately. The weight of any gas present in the propellant tanks during vehicle weighing shall be determined. Weighing requirements shall be defined by the Structures organization. Only those LBII items which can be weighed conveniently shall be weighed.

3.1.2.6 Vehicle Assembly Alignments. The following vehicle equipment alignments shall be verified to the requirements of LMSC Drawing 1389602:

- a. Thrust Valve Centerlines
- b. Engine Nozzle Centerline
- c. Engine Gimbal Axis

- d. Engine Nozzle Angular Travel
- e. Turbine Exhaust Duct
- f. Propellant Vent Tubes
- g. Inertial Sensor Assembly
- h. DACS Module (when applicable)

3.1.2.7 Primary Battery Fit Check. A fit check of the primary batteries shall be performed. Inert nonflight batteries may be used for this test. The batteries shall be installed and wire harnesses connected. The battery fit and harness connections shall be in accordance with LMSC Drawing 1389603.

3.1.2.8 Vehicle Antenna System VSWR Test. The VSRW and line losses of the antenna system for the transmit and receive functions of the telemetry and command systems shall be measured at the assigned transmit and receive frequencies. The line losses between the shuttle interface and the system shall also be measured.

The test methods and requirements shall be similar to those specified in paragraph 4.4.2.8.2.7 (S-Band Antenna System) of LMSC Specification 1419628.

3.1.2.9 Vehicle-Supporting Cradle Tests. These tests shall include the following:

- a. A mate and fit check between the vehicle-supporting cradle(s) and the vehicle assembly to verify the drawing requirements for alignment, fit, clearances, and compatibility of attachment points
- b. A mate and fit check between the cradle and a jig simulating orbiter payload bay attach points and deployment mechanism (if applicable)
- c. Weight and CG tests for weighing requirements shall be defined by the Structures organization.

3.1.2.10 Vehicle Assembly Shakedown Inspection. The vehicle assembly, vehicle-supporting cradle, and LBII kit shall be subjected to shakedown inspection by Product Assurance upon completion of the manufacturing effort. A specific shakedown inspection checklist shall be prepared by Product Assurance project management for this vehicle assembly. Included is a general inspection of electrical cables, mechanical

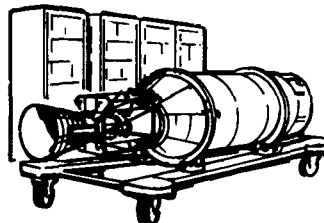
connections, clamps, supports, cleanliness, etc. Provision is made in the checklist to record configuration controlled article (CCA) numbers of inspected equipment when applicable.

The shakedown inspection and related operations shall include the following quality operating instructions:

- | | |
|-------------|--|
| Q01 1602-02 | Shakedown Inspection Check Lists, Preparation and Maintenance of |
| Q01 2103-01 | Vehicle Final Assembly Inspection |
| Q01 2105-01 | Vehicle Shakedown Inspection |

Subsequent to this inspection, the vehicle complete kit shall be submitted to condition of assembly for release and transfer (CART) action negotiations. When CART is complete, the vehicle complete kit shall be delivered to Building 156 and jurisdiction of the vehicle transferred to the Agena System Test organization. Intraplant shipping requirements of par. 5.0 of LMSC Specification 1420787 shall be complied with.

If the LBII kit is not available when the vehicle assembly is submitted for CART, it may be CART'd separately.



SYSTEM TEST

3.2. VEHICLE SYSTEM TEST PROGRAM

The requirements for all program system tests to be performed before the vehicle is shipped to the launch base are established in this section. These tests will be performed after CART and before initiation of program/customer presentations for the

vehicle complete kit. This testing consists primarily of system tests of vehicle electrical, guidance, telemetry, and pyrotechnic systems. The numbers of all test procedures required to implement the testing are listed in MPL S40000-XXXX prepared by the LVP Systems Test organization.

The vehicle assembly will be subjected to system and simulated flight testing at ambient and at environmental (thermal-vacuum) conditions to verify the acceptance test requirements of the LMSC specifications referenced herein. The ambient tests will include both pre-environmental and post-environmental testing.

The first vehicle assembly will be subjected to electromagnetic compatibility (EMC) tests during the pre-environmental testing. The EMC tests will be performed to verify that the no malfunction intent of MIL-E-6051C has been achieved at critical circuitry points. The tests will demonstrate an adequate margin of safety between the vehicle equipment design requirements and the levels of narrowband noise and transients on the unregulated power line and will verify proper vehicle operation during exposure to radiation levels simulating the effects of the shuttle, vehicle, and payload transmitters, except that the radiation levels shall be higher than the values calculated to exist during normal operation.

Prior to initial vehicle system tests, proper operation of the guidance computer (GC) shall be verified and the inertial sensor assembly (ISA) calibrated. The ISA shall again be calibrated subsequent to the environmental testing.

Upon completion of the first simulated flight test, the vehicle assembly will be transferred to a high-pressure test cell (HPTC), where functional tests, leak checks, and servicing of the propulsion, pneumatic attitude control, and hydraulic attitude control systems will be performed. The launch base installed items kit will not be required for the HPTC tests. Upon completion of HPTC testing, the vehicle assembly will be moved to a thermal-vacuum facility, where system tests will be performed in a controlled thermal-vacuum environment. Upon completion of the environmental system tests, the vehicle assembly will be returned to the ambient test station, where the final system tests will be performed.

All testing and other operations specified in par. 3.2 of this test plan will be performed by or under the direction and cognizance of LVP Systems Test. Those tests on the following pages followed by an asterisk (*) are mandatory to demonstrate compliance with the requirements of LMSC Specification (TBD) for the Agena tug vehicle complete kit. All other tests will be performed as confidence or operational tests.

Those tests from which data are to be obtained and recorded in the data table to be presented as a basis for vehicle complete kit acceptance at program/customer acceptance negotiations are followed by a plus (+).

3.2.1 Pre-Environmental System Tests

Subsequent to CART, the vehicle assembly shall be transferred to a system test station, where system tests shall be performed under ambient conditions. Tests to demonstrate proper vehicle/PSE (program support equipment) hookup and to check out vehicle circuitry will be performed before power is applied to the vehicle. Individual tests and simulated flight tests as described below will then be performed.

The simulated flight tests will exercise all vehicle primary and backup functions by a timed sequence of events simulating a countdown, ascent, and orbit procedure. The simulated flight tests will be the primary source for vehicle-sell data. Vehicle data will be supplied primarily by vehicle telemetry, with a minimum of hardline data via the umbilical. The telemetry data shall be recorded for post-test analysis. Realtime monitoring of all vehicle critical functions shall be performed. Simulated shuttle commands supplied to the vehicle via the Agena/payload service panel shall be continuously monitored by the GSE. The PCM bit stream will be continuously recorded when the PCM system is on.

Monitoring equipment shall be connected to the equipment under test to ensure that operating and nonoperating limits are not exceeded. During testing, certain precautions

and operating conditions, similar to those specified in the following paragraphs of LMSC Specification 1420780, Part II, shall be enforced:

- 4.3.1 Atmospheric Conditions
- 4.3.2 Electrical Test Power Source
- 4.3.2.2 Inertial Sensor Assembly Operation
- 4.3.3.1 HPP Output Hydraulic Pressure Source
- 4.3.4.1 Nitrogen Source
- 4.3.4.2 Helium Source
- 4.3.5 Operation of the Guidance Computer
- 4.3.6 Controlled Conditions
- 4.3.7 Controlled Operating Time
- 4.3.8 Test Precautions
- 4.3.9 Test Instrumentation
- 4.3.10 Measurement Accuracy
- 4.3.11 Vehicle Bus Resistance
- 4.3.13 Tubing, Fitting, Instruments & Other Equipment
- 4.3.13.1 Tube Connections
- 4.3.13.2 Tube Replacement, Component Replacements &
 Brazed Joint Repairs in Plumbing Systems
- 4.3.13.3 Flared Tubing and Fitting Rejections
- 4.3.14 Gas Fill Checkout Coupling
- 4.3.15 Propellant Tank Bulkhead Reversal Precautions
- 4.3.16 Pressure Limits
- 4.3.16.1 General Personnel Exposure
- 4.3.16.2 Limited Personnel Exposure
- 4.3.17 Lubrication
- 4.3.20.1 Pressurization, Helium Sphere
- 4.3.20.2 Depressurization, Helium Sphere
- 4.3.21 Tank Pressure Balance
- 4.4.4 Electrical System Tests
- 4.4.4.1 Vehicle Main & Pyro Bus Voltage Test
- 4.4.9.5 Vehicle Instrumentation Data Recovery Tests

3.2.1.1 Inertial Sensor Assembly Calibration. Prior to vehicle system testing, the inertial sensor assembly (ISA) shall be sent to a calibration facility for calibration. Precise positioning of the ISA during the calibration shall be provided by mounting the unit on a rate table. The guidance computer (GC) may be removed from the vehicle to support the calibration, if required. The calibration of the ISA and the operation of the GC shall be in accordance with the following paragraphs of LMSC Specification 1419780, Part II:

4.3.5 Guidance Computer Operation

4.4.5.1 Rate and Acceleration Sensing Test**

Care shall be exercised in handling the ISA. The original shipping container (or equivalent) shall be used in transporting the unit between facilities.

3.2.1.2 Vehicle/PSE Hookup, Conditioning, and Pre-Power Tests. Subsequent to PSE hookup and prior to turning on vehicle power, tests shall be conducted to verify proper hookup and vehicle configuration and to prepare the vehicle for the simulated flight tests.

The vehicle test setup shall include the following conditions:

- a. Vehicle assembly pressure systems externally connected (as necessary)
- b. Thrust valves electrically simulated
- c. Propulsion simulator connected (test aid to simulate necessary propulsion system functions)
- d. Pyro test harness (installation subsequent to pyro sure-fire tests)
- e. Payload electrical interface simulated
- f. Agena/payload service panel connected
- g. Antenna coupler installed
- h. DACS horizon sensor programmable targets installed (when applicable)

The vehicle bus and fusistor resistances shall be determined and proper identification of pyro circuits verified. A hydraulic fluid filtering and sampling test shall be performed.

Compliance with requirements similar to those in the following paragraphs of LMSC Specification 1420780, Part II, shall be demonstrated:

- 4.3.11 Vehicle Bus Resistance*
- 4.4.3a Pyro Circuits Identification*
- 4.4.3.1.1 Pyrotechnic Fusistor Tag Validation Test*
- 4.4.6.1 Hydraulic System Cleanliness*

3.2.1.3 Vehicle Power-On Tests. After the pre-power tests and before the vehicle functional tests described in subsequent paragraphs, the electrical power systems shall be checked for conformance to requirements similar to those specified in the following paragraphs of LMSC Specification 1420780, Part II:

- 4.4.4.1 Vehicle Main & Pyro Bus Voltage Test**
- 4.4.4.2 Vehicle Power Transfer Test*

3.2.1.4 Guidance Computer Self-Checks. Diagnostic self-checks of the guidance computer memory and input/output processor functions shall be performed prior to the simulated flight tests. The self-checks shall be performed by programming the guidance computer from the diagnostic test tape. Compliance with requirements similar to those specified in the following paragraph of LMSC Specification 1420780, Part II, shall be demonstrated:

- 4.4.5.2 Guidance Computer*

3.2.1.5 Pyro System Tests. A test shall be performed to verify the capability of each vehicle pyrotechnic circuit to supply current exceeding the minimum sure-fire current requirements associated with each applicable pyrotechnic device and to verify enable/disable

control of the guidance computer pyro discrete circuits via the umbilical. The test methods and requirements shall be similar to those specified in the following paragraphs of LMSC Specification 1420780, Part II:

- 4.4.3b Vehicle Arm Plugs
- 4.4.3.2 Pyro Enable/Disable and Sure-Fire Tests**

3.2.1.6 Hydraulic System Tests. Prior to the simulated flight test, the hydraulic system shall be checked for null and stability, step response, and phasing. The tests shall be performed using the HGTU connected to the pump side of the HPP. The response to step input pitch and yaw error signals, programmed by the guidance computer, shall be determined from time history plots of actuator motions for both extend and retract conditions. The phasing test shall be performed by providing error inputs through physical movement of the vehicle and visually verifying proper hydraulic actuator response. The nozzle extension (nonflight) shall be installed for this test. The tests shall demonstrate compliance with requirements similar to those specified in the following paragraphs of LMSC Specification 1420780, Part II:

- 4.4.5.4.1 F/C Hydraulic System Null & Stability Tests**
- 4.4.5.4.2 F/C Hydraulic System Step Response Test**
- 4.4.5.4.4 F/C Hydraulic System Static Range Test**
- 4.4.5.4.5 Hydraulic System Phasing Test*
- 4.4.6 (a through h) Hydraulic Attitude Control System Tests

3.2.1.7 Flight Control Pneumatic System Phasing Test. An end-to-end phasing test of the F/C pneumatic attitude control system shall be performed by providing error inputs through physical movement of the vehicle and determining correct gas valve actuation. The test shall demonstrate compliance with requirements similar to those specified in the following paragraphs of LMSC Specification 1420780, Part II:

- 4.4.5.5 Flight Control Pneumatic System Tests
- 4.4.5.5.5 F/C Pneumatic System Phasing Test*
- 4.4.7 (a through e) Pneumatic Attitude Control System Tests

3.2.1.8 Engine Start/Shutdown Redundant Wiring Test. The vehicle shall be subjected to an engine start/shutdown test sequence that will validate all redundant engine control circuitry. The test sequence shall be programmed from the guidance computer, using the integrated test tape. The test shall demonstrate compliance with requirements similar to those specified in the following paragraph of LMSC Specification 1420780, Part II:

4.4.2.2.2 Engine Start/Shutdown Redundant Wiring Test*

3.2.1.9 Electrical System High- and Low-Voltage Tests. Vehicle operation at high and low bus voltage inputs shall be demonstrated from TLM verifications of ISA and GC internal voltages and instrumentation data recovery requirements. The test shall demonstrate compliance with high-low voltage requirements similar to those specified in the following paragraph of LMSC Specification 1420780, Part II:

4.4.4.3 High-Low Bus Voltage Tests*+

3.2.1.10 Solar Array Tests. (a) The solar array assembly shall be checked to verify that the electrical circuitry from the solar array connectors through the charge controller to the battery connectors provides the required current-carrying capability and voltage-drop characteristics. The test methods and requirements will be similar to those specified in the following paragraphs of LMSC Specification 1420961:

4.4.6.2 Solar Array Electrical Tests⁺

4.4.6.2.1.1 Spacecraft Bus System Voltage Drop and Current Carrying Capability⁺

3.2.1.11 TT&C Systems Tests. The TT&C (telemetry, tracking, and command) system as configured for the Agena tug shall be tested for functional performance to requirements similar to those specified in the following paragraphs of LMSC Specifications 1420961 and 1420780:

Specification 1420961

4.3.1.5 Simulations⁺

4.4.6.2.4 Telemetry Monitor Verification⁺

(a)Applicable to 30-day mission configuration

| | |
|--------------|---|
| 4.4.6.2.5.1 | Spacecraft Bus Charge Controller Command ⁺ |
| 4.4.10.4 | Telemetry Instrumentation and Calibrations ⁺ |
| 4.4.11.1 | Command Operations ⁺ |
| 4.4.11.1.1 | Signal Characteristics ⁺ |
| 4.4.11.1.2 | Command Receiver Threshold Sensitivity ⁺ |
| 4.4.11.1.3 | Command Protection ⁺ |
| 4.4.11.1.4 | Command Receiver TLM Power Level ⁺ |
| 4.4.11.1.5 | Tracking and Command Uplink ⁺ |
| 4.4.11.1.5.1 | Receiver Phase-Lock Test ⁺ |
| 4.4.11.2 | <i>Tracking System – Ranging Signal⁺</i> |
| 4.4.11.3.1 | TLM Transmitter Preset Carrier Frequency ⁺ |
| 4.4.11.3.2 | Encryption ⁺ |
| 4.4.11.3.3 | Subcarrier Frequencies ⁺ |
| 4.4.11.3.4 | Baseband Assembly Unit Signal Input ⁺ |
| 4.4.11.3.5 | Modulation Index ⁺ |
| 4.4.11.4 | Antenna System Tests ⁺ |

Specification 1420780

| | |
|-------------|---|
| 4.4.9.5.4.2 | ISA and GC Internal Voltage Checks ⁺ |
| 4.4.9.5.6 | Turbine Speed Simulation ⁺ |
| 4.4.9.5.10 | AGS No. 1 Serial Data Test ⁺ |

3.2.1.12 DACS Tests. ^(a) The DACS (dual attitude control system) as configured for the Agena tug/OOS shall be tested for functional performance to requirements similar to those specified in the following paragraphs of LMSC Specification 1419628:

| | |
|-------------|---|
| 4.4.2.3.1.1 | Polarity, Scale Factor, and Null Tests ⁺ |
| 4.4.2.3.1.2 | Output with Pitch Bias ⁺ |
| 4.4.2.3.1.3 | Inhibit ⁺ |
| 4.4.2.3.1.3 | Head Pressure ⁺ |
| 4.4.2.3.3.1 | Decoupling Gains ⁺ |
| 4.4.2.3.3.2 | Random Drift ⁺ |
| 4.4.2.3.3.3 | Response to Horizon Sensor Assembly (HSA) Inputs ⁺ |

^(a)Applicable to 30-day mission configuration

| | |
|-------------|---|
| 4.4.2.3.3.4 | Programmed Torquing ⁺ |
| 4.4.2.3.3.5 | Polarity Gyro Reference Assembly (GRA) ⁺ |
| 4.4.2.3.4.1 | Static Gains ⁺ |
| 4.4.2.3.4.2 | Deadbands ⁺ |
| 4.4.2.3.4.3 | Dynamic Transfer Functions ⁺ |
| 4.4.2.3.4.4 | Nulls (Pneumatic) ⁺ |
| 4.4.2.3.4.5 | Polarities (Pneumatic) ⁺ |
| 4.4.2.3.4.6 | Failure Detection Circuits ⁺ |
| 4.4.2.3.4.8 | Minimum Impulse Bit ⁺ |
| 4.4.2.3.4.9 | Thrust Levels ⁺ |

3.2.1.13 EMI Tests. EMI tests shall be conducted on the vehicle assembly prior to performing the initial simulated flight test. EMI test equipment shall be connected to the vehicle, and the short circuits at the pyrotechnic squib connectors shall be replaced with squib simulators of the bridgewire type. The Agena/payload service panel shall be connected during the test. The following EMI tests shall be performed during one simulated flight test in accordance with test methods similar to those specified in the following paragraphs of the Interference Control Plan (LMSC-1420793). During the simulated flight test, the squib simulators shall be monitored for premature firing.

| | |
|-------|-------------------------------------|
| 5.2.1 | Unregulated Power Narrowband Noise |
| 5.2.2 | Unregulated Power Transients to GCA |
| 5.2.3 | Booster Transmitter Radiation |
| 5.2.4 | Vehicle Transmitter Radiation |
| 5.2.5 | Payload Transmitter Radiation |

Subsequent to the EMI test, the arm plug shall be removed and the pyro test harness installed.

3.2.1.14 Vehicle Fusistor Drift Test. Subsequent to the EMI test, the fusistor shall be checked for drift. The test shall be performed in accordance with requirements similar to those specified in the following paragraph of LMSC Specification 1420780, Part II:

| | |
|-----------|----------------------|
| 4.4.3.1.2 | Fusistor Drift Test* |
|-----------|----------------------|

3.2.1.15 Simulated Launch-Readiness and Flight Test. A simulated launch-readiness and flight test shall be performed. The test shall demonstrate the functional performance capabilities of the vehicle to meet mission requirements as specified in the Agena tug detail model specification. Vehicle configuration shall be as defined in par. 3.2.1.2. The test will include verification of all vehicle flight functions. Input and output data monitoring will be primarily by TLM, with a minimum amount via the umbilical. Shuttle and payload interface requirements will also be verified. The AGS computer will be programmed to provide a timed sequence of events and appropriate steering and discrete commands to verify performance of the vehicle hydraulic and pneumatic systems. TT&C commands will be issued to verify operational transfer capabilities between the AGS and DACS systems and to verify the functional performance of the DACS control systems (applicable only for 30-day mission configuration).

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| | |
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| 4.4.2.2.1 | Engine Start/Shutdown Electrical Tests* |
| 4.4.5.3 | Static Navigation** |
| 4.4.5.4.3 | F/C Hydraulic System Gain Tests** |
| 4.4.5.5 | F/C Pneumatic System Tests* |
| 4.4.5.5.1 | F/C Pneumatic System Modulation Factor Tests** |
| 4.4.5.5.2 | F/C Pneumatic System Deadband Tests** |
| 4.4.5.5.3 | F/C Pneumatic System Rate Gain Tests** |
| 4.4.5.5.4 | F/C Pneumatic System Null Tests** |
| 4.4.9.5.3 | Pressure Calibration Check (D159)** |
| 4.4.10 | Vehicle Functional Event Tests |
| 4.4.10.1 | Vehicle Test Configuration |
| 4.4.10.1.1 | Launch Base Installed Items |
| 4.4.10.1.3 | Electrical System |
| 4.4.10.2 | Baseline (Ø1) Simulated Flight Test** |

Specification 1419628 (Applicable to 30-Day Mission Configuration)

| | |
|-------------|--|
| 4.4.2.3 | Dual Attitude Control System (DACS) Tests* |
| 4.4.2.3.1.1 | Polarity, Scale Factor and Null Tests* |
| 4.4.2.3.1.2 | Output with Pitch Bias (AGS only)* |
| 4.4.2.3.1.3 | Inhibit* |

- 4.4.2.3.3.1 Decoupling Gains*
- 4.4.2.3.3.2 Random Drift*
- 4.4.2.3.3.3 Response to HSA Inputs*
- 4.4.2.3.3.4 Programmed Torquing**
- 4.4.2.3.3.5 Polarity (GRA)**
- 4.4.2.3.4.1 Static Gains*
- 4.4.2.3.4.2 Deadbands*
- 4.4.2.3.4.5 Polarities (Pneumatic)*

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- 4.4.6.2.5.1 Spacecraft Bus Charge Controller Command*

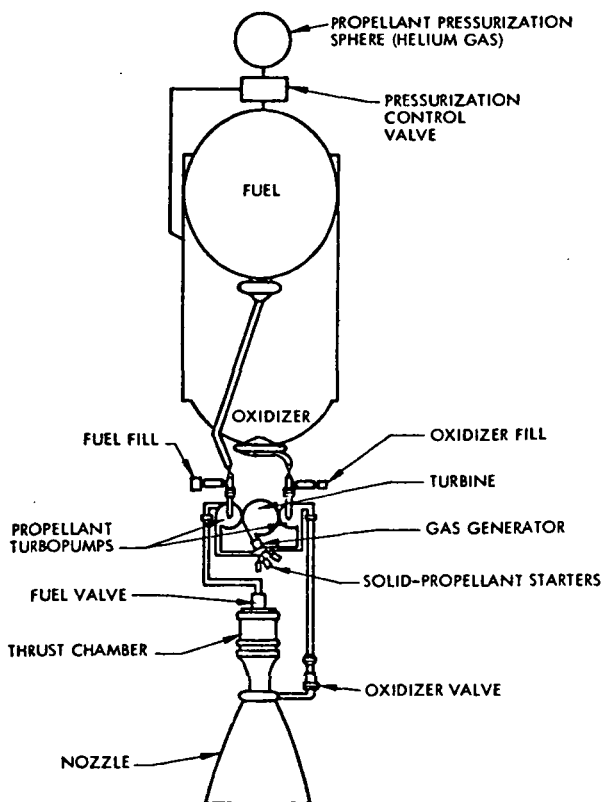
3.2.2 High-Pressure Test Cell Tests

After the ambient systems tests (par. 3.2.1 above) and before the environmental tests (par. 3.2.3 below), the vehicle assembly will be transferred to a high-pressure test cell facility, where leak checks, performance demonstrations, and servicing of the vehicle assembly propulsion, hydraulic, and pneumatic systems shall be accomplished as described in the following paragraphs.

Monitoring equipment shall be connected to the vehicle to ensure that during all tests vehicle operating and nonoperating limits are not exceeded. During vehicle testing, certain precautions shall be enforced similar to those specified in the following paragraphs of LMSC Specification 1420780, Part II:

- 4.3.1 Atmospheric Conditions
- 4.3.3.1 Hydraulic Power Package Output
Hydraulic Pressure Source
- 4.3.3.2 Engine Turbine Pump Unsymmetrical
Dimethyl Hydrazine Pressure Source
- 4.3.4.1 Nitrogen Source
- 4.3.4.2 Helium Source
- 4.3.6 Controlled Conditions
- 4.3.7 Controlled Operating Time
- 4.3.8 Test Precautions

- 4.3.10 Measurement Accuracy
- 4.3.12.2 Engine Seal Venting
- 4.3.13 Tubing, Fittings, Instruments and Other Equipment
 - 4.3.13.1 Tube Connections
 - 4.3.13.2 Tube Replacement, Component Replacements and Brazed Joint Repairs in Brazed Plumbing Systems
 - 4.3.13.3 Flared Tubing and Fitting Rejection
- 4.3.14 Gas Fill Checkout Coupling
- 4.3.15 Propellant Tank Bulkhead Reversal Precautions
- 4.3.16 Pressure Limits
 - 4.3.16.1 General Personnel Exposure
 - 4.3.16.2 Limited Personnel Exposure
 - 4.3.16.3 Remote Operation
 - 4.3.16.4 Turbine Exhaust Duct Pressurization
- 4.3.17 Lubrication
- 4.3.18 Propulsion System Moisture/Salt Corrective Action
- 4.3.19 Brazed Plumbing Leakage
- 4.3.20.1 Pressurization (Helium Sphere)
- 4.3.20.2 Depressurization (Helium Sphere)
- 4.3.21 Tank Pressure Balance



3.2.2.1 Propulsion System Tests. The propulsion system shall be leak-checked and functionally tested in accordance with requirements similar to those specified in the following paragraphs of LMSC Specification 1420780:

- 4.3.12.1 Engine Contamination*
- 4.4.2.1.1 Gas Generator Propellant Valve (GGPV)
Functional Test*
- 4.4.2.1.2 Fuel Valve Functional Test*
- 4.4.2.1.3 Oxidizer Manifold Pressure Switch (OMPS)
Functional Test*
- 4.4.2.1.4 Pilot Operated Solenoid Valve (POSV)
Functional Test*
- 4.4.2.1.5 Oxidizer Valve Functional Test*
- 4.4.2.1.6.1 PIV Actuation Closing Test*
- 4.4.2.1.6.2 PIV Actuation Opening Test*
- 4.4.2.1.7 Bellows Alignment Inspection*
- 4.4.2.1.8 Engine Cleanliness and General Inspection*
- 4.4.2.1.9 Lip Seal Check Valve Functional Test*
- 4.4.2.1.10 Helium Fill Coupling Functional Test*
- 4.4.2.2.3 POSV, GGSV and OMPS Electrical Connections
Validation Tests*
- 4.4.2.3.1 Propellant Tank Bulkhead Leak Check*
- 4.4.2.3.2 Propulsion System Low Pressure General Checks*
- 4.4.2.3.3 Propellant Pressurization System High Pressure
Leakage Checks*
- 4.4.2.3.4.1 PIV Open Position Leakage Checks*
- 4.4.2.3.4.2 PIV Closed Position Leakage Checks*
- 4.4.2.3.5.1 Lip Seal Check Valve Internal Leakage*
- 4.4.2.3.5.2 Lip Seal Check Valve External Leakage*
- 4.4.2.3.6.3 GGSV Leakage*
- 4.4.2.3.6.4 Fuel Valve Leakage*
- 4.4.2.3.6.5 Thrust Chamber Leakage*
- 4.4.2.3.6.6 Fuel Valve Frangible Disc Leakage*
- 4.4.2.3.6.7 OMPS Leakage*
- 4.4.2.3.6.8 POSV Combined Leakage*
- 4.4.2.3.6.9 POSV Flush Port Leakage*

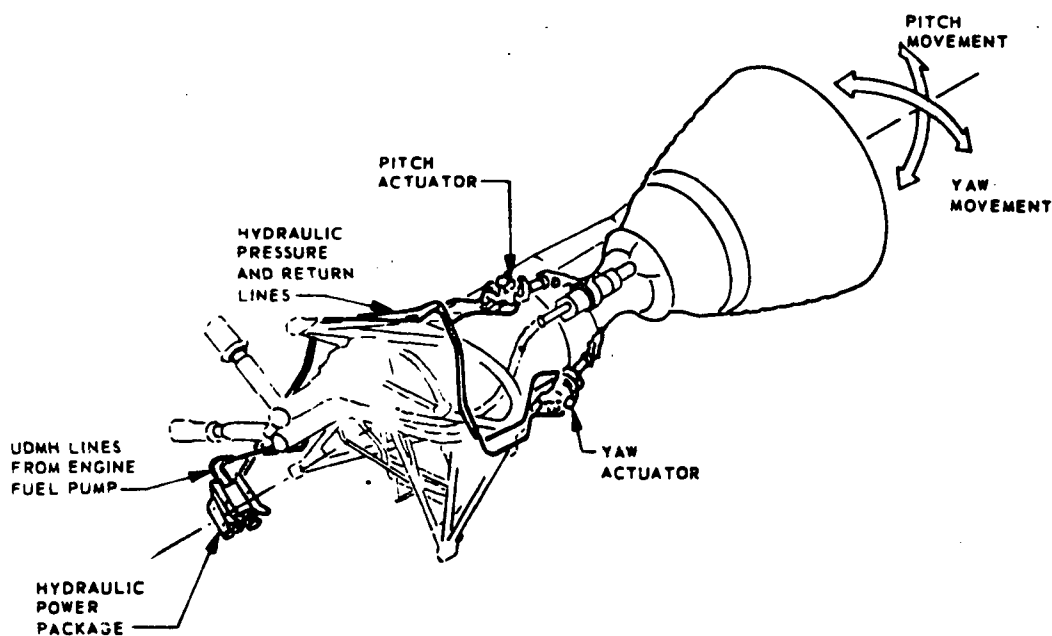
| | |
|--------------|--|
| 4.4.2.3.6.10 | POSV Poppet Leakage* |
| 4.4.2.3.6.11 | Oxidizer Valve Seat Leakage* |
| 4.4.2.3.6.12 | Oxidizer Valve Frangible Disc Leakage* |
| 4.4.2.3.6.13 | Oxidizer Pump Lip Seal Leakage* |
| 4.4.2.3.6.14 | Fuel Pump Secondary Seal Leakage* |
| 4.4.2.3.6.15 | Oxidizer and Fuel Pump Primary Seal Leakage* |
| 4.4.2.3.6.18 | Turbine Drive Seal Leakage* |
| 4.4.2.3.6.19 | Turbine Gear Case Leakage* |
| 4.4.2.4 | Propulsion System Moisture Content Checks* |

In addition to the above tests, the multiple-start system shall be subjected to functional and leakage checks as specified in BAC Handbook 8247-954201 that will include the following:

Electronic Gate Overspeed Control Test*

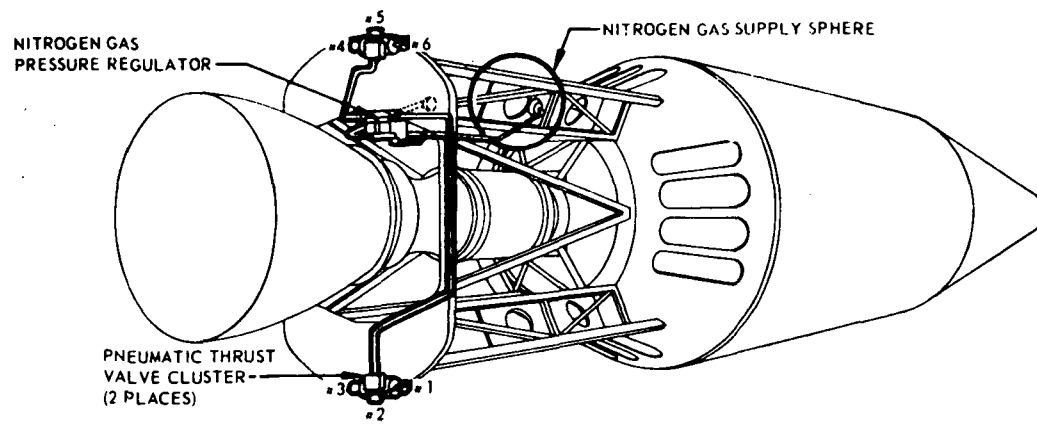
Gas Generator Solenoid Valve (Fuel and Oxidizer) Functional Test*

Static Leakage Checks of Tanks, Fill Valves, Check Valves, Lines,
and Fittings



3.2.2.2 Hydraulic Attitude Control System Tests. The hydraulic system shall be leak-checked and functionally tested in accordance with requirements similar to those specified in the following paragraphs of LMSC Specification 1420780, Part II:

- 4.4.6 Hydraulic Attitude Control System Tests*
- 4.4.6.1 Hydraulic System Cleanliness*
- 4.4.6.2 Hydraulic Power Package (HPP) Functional Tests*
- 4.4.6.2.2 HPP Motor-Pump Operation*
- 4.4.6.2.3 Hydraulic System Gimbal Velocity Tests*
- 4.4.6.3 Hydraulic System External Leakage Check*



3.2.2.3 Pneumatic Attitude Control System Tests. The pneumatic system shall be leak-checked and functionally tested in accordance with requirements similar to those specified in the following paragraphs of LMSC Specification 1420780, Part II:

- 4.4.7 Pneumatic Attitude Control System Tests
- 4.4.7.1 Pneumatic Attitude Control System Functional Tests
- 4.4.7.1.1 a Pneumatic Regulator Low-Pressure-Mode Test*
- 4.4.7.1.1 b Pneumatic Regulator High-Pressure-Mode Test*
- 4.4.7.1.2 a Pneumatic Regulator High-Mode Regulated Pressure Tests*
- 4.4.7.1.2 b Pneumatic Regulator Low-Mode Regulated Pressure Tests*

| | |
|-----------|---|
| 4.4.7.1.3 | Attitude Control System Flow Test* |
| 4.4.7.2 | Nitrogen Fill-Coupling Functional Tests* |
| 4.4.7.3a | Pneumatic System Plumbing Leakage Checks* |
| 4.4.7.3b | Pneumatic System Regulator Relief-Valve Leakage Checks* |
| 4.4.7.3c | Lip-Seal Leakage Check* |
| 4.4.7.3d | Nitrogen Fill-Coupling Leakage Check* |
| 4.4.7.3e | Thrust Valve Leakage Check* |
| 4.4.7.4 | Pneumatic Gas Moisture Check* |

3.2.2.4 DACS Leakage and Component Functional Tests. (a) The DACS pneumatic system shall be leak-checked and functionally tested. The test methods and requirements will be similar to those specified in the following paragraphs of LMSC Specification 1419628:

| | |
|---------------|---|
| 4.4.2.3.6 | DACS Pneumatic System Leakage and Component Functional Tests* |
| 4.4.2.3.6.1.1 | Low Pressure Side System Leakage* |
| 4.4.2.3.6.2.1 | High Pressure Side System Leakage* |
| 4.4.2.3.6.2.2 | Pneumatic Regulators External Leakage* |
| 4.4.2.3.6.2.3 | Latching Solenoid Valve Leakage* |
| 4.4.2.3.6.2.4 | Nitrogen Fill Coupling Leakage* |
| 4.4.2.3.6.3 | Pneumatic Regulators Function* |
| 4.4.2.3.6.3.1 | Regulation* |
| 4.4.2.3.6.3.2 | Pressure Step Input* |
| 4.4.2.3.6.5.1 | Nitrogen Isolation Valve (NIV) Actuation* |
| 4.4.2.3.7.1 | Moisture (pneumatic gas)* |

3.2.3 Environmental (Thermal-Vacuum) System Tests

After the high-pressure test cell tests (par. 3.2.2 above), the vehicle assembly shall be installed in a thermal-vacuum chamber. Simulated flight tests will be performed at both low and high temperature while at altitude.

(a) Applicable to 30-day mission configuration

Flight environment and temperature sensor instrumentation requirements shall be provided by the Spacecraft Thermodynamics organization.

Monitoring equipment shall be connected to the vehicle to ensure that during all tests vehicle operating and nonoperating limits are not exceeded. During vehicle testing, certain precautions shall be enforced similar to those specified in the following paragraphs of LMSC Specification 1420780, Part II:

- 4.3.2 Electrical Test Power Source
- 4.3.5 Operation of the Guidance Computer
- 4.3.6 Controlled Conditions
- 4.3.7 Controlled Operating Time
- 4.3.8 Test Precautions
- 4.3.9 Test Instrumentation
- 4.3.10 Measurement Accuracy
- 4.3.11 Vehicle Bus Resistance
- 4.3.13 Tubing, Fitting, Instruments & Other Equipment
 - 4.3.13.1 Tube Connections
 - 4.3.13.2 Tube Replacement, Component Replacements,
and Brazed Joint Repairs in Brazed
Plumbing Systems
 - 4.3.13.3 Flared Tubing and Fitting Rejections
- 4.3.15 Propellant Tank Bulkhead Reversal Precautions
- 4.3.16 Pressure Limits
 - 4.3.16.1 General Personnel Exposure
- 4.3.21 Tank Pressure Balance
- 4.4.4a, b Electrical System Tests
- 4.4.9.5 Vehicle Instrumentation Data Recovery

3.2.3.1 Vehicle/PSE Hookup, Conditioning, and Pre-Power Test. Subsequent to PSE hookup and prior to turning on vehicle power, tests will be conducted to verify proper hookup and vehicle configuration and to prepare the vehicle for simulated flight tests. The vehicle shall include the following items and conditions:

Vehicle assembly

Shuttle interface panel electrically mated to the vehicle
(first vehicle only)

DACS H/S programmable targets installed
Payload test harness installed and payload electrical interface simulated
Antenna coupler installed on the antenna
No external pressure sources connected to the vehicle assembly
Forward rack doors (removed from LBII kit) installed
Thermal sensors installed and checked out
Propellant expulsion tubes plugged
Engine seal cavity drain lines uncapped
HPP shaft seal drain plug installed
HPP low-pressure relief valve vent port plugged
Protective (Expando) wrap assembly PHE 21-1016-501 removed from the propellant tank in accordance with Material Handling and Packaging Standard, Vol 1, MHPS 7500-H207B, paragraph 3.2.4. The -303 wrap liners will not be reinstalled and may be discarded.
Pyro test harnesses installed
Thrust valves electrically simulated

NOTE

The solar array wing (30-day mission configuration) shall not be installed for the thermal-vacuum tests.

The vehicle bus resistances shall be measured to demonstrate compliance with the following paragraph of LMSC Specification 1420780, Part II:

4.3.11 Vehicle Bus Resistance

3.2.3.2 Vehicle Power Test. Subsequent to conducting the pre-power tests (par. 3.2.3.1 above) and while still at ambient pressure, the vehicle main and pyro bus voltages shall be checked for proper setting and noise. The requirements shall be similar to those specified in the following paragraph of LMSC Specification 1420780, Part II:

4.4.4.1 Vehicle Main and Pyro Bus Voltage Test

3.2.3.3 Simulated Launch-Readiness and Flight Tests at Low Temperature. With the thermal-vacuum chamber pumped down and stabilized at the low temperature, a simulated flight test shall be performed to demonstrate proper vehicle response to simulated shuttle and vehicle initiated commands. This test is essentially a repeat of the pre-environmental simulated flight test (par. 3.2.1). Vehicle configuration is defined in par. 3.2.3.1.

Compliance with requirements similar to those specified in the listed paragraphs of the following LMSC specifications shall be demonstrated:

Specification 1420780

| | |
|------------|---|
| 4.4.2.2.1 | Engine Start/Shutdown Electrical Tests |
| 4.4.5.3 | Static Navigation |
| 4.4.5.5 | F/C Pneumatic System Tests |
| 4.4.5.5.1 | F/C Pneumatic System Modulation Factor Tests |
| 4.4.5.5.2 | F/C Pneumatic System Deadband Tests |
| 4.4.5.5.3 | F/C Pneumatic System Rate Gain Tests |
| 4.4.5.5.4 | F/C Pneumatic System Null Tests |
| 4.4.10 | Vehicle Functional Event Tests |
| 4.4.10.1 | Vehicle Test Configuration |
| 4.4.10.1.1 | Launch Base Installed Items |
| 4.4.10.1.3 | Electrical System |
| 4.4.10.3.1 | Environmental Atmospheric Conditions |
| 4.4.10.3.2 | Environmental Test and Controlled Conditions |
| 4.4.10.3.4 | Environmental (Ø2B Cold Soak) Simulated Flight Test |

Specification 1419628 (Applicable to 30-Day Mission Configuration)

| | |
|-------------|--|
| 4.4.2.3 | DACS Tests |
| 4.4.2.3.1.1 | Polarity, Scale Factor, and Null Tests |
| 4.4.2.3.1.2 | Output with Pitch Bias |
| 4.4.2.3.3.1 | Decoupling Gains |
| 4.4.2.3.3.2 | Random Drift |
| 4.4.2.3.3.3 | Response to HSA Inputs (TLM only) |

| | |
|-------------|--------------------------------|
| 4.4.2.3.3.4 | Programmed Torquing (TLM only) |
| 4.4.2.3.3.5 | Polarity (GRA) |
| 4.4.2.3.4.1 | Static Gains |
| 4.4.2.3.4.2 | Deadbands |
| 4.4.2.3.4.5 | Polarities |

3.2.3.4 Simulated Launch-Readiness and Flight Tests at High Temperature. With the thermal-vacuum chamber pumped down and stabilized at the high temperature, a simulated flight test shall be performed to demonstrate proper vehicle response to simulated shuttle and vehicle initiated commands. This test shall be identical to the simulated flight test at low temperature, paragraph 3.2.3.3 above, except for the temperature of the chamber.

3.2.3.5 Vehicle Disconnect. Subsequent to the high-temperature thermal-vacuum test, the vehicle assembly shall be disconnected and returned to an ambient test station for final system tests. The forward rack doors shall be removed and returned to the LBII kit. The protective (Expando) wrap assembly PHE 21-1016-501 on the propellant tank shall be installed in accordance with Material Handling and Packaging Standard, Vol 1, MHPS 7500-H207B, par. 3.2.2, except that the -303 wrap liners shall not be reinstalled.

3.2.4 Post-Environmental (Ambient) System Tests

Subsequent to performing the tests in the thermal-vacuum chamber, the vehicle assembly shall be returned to an ambient test station, where final systems tests shall be performed under ambient conditions. The primary purpose of these tests is to verify that the vehicle assembly performance has not been degraded by handling, HPTC testing and servicing, or environmental testing.

The final ambient system tests shall include a repeat of the following pre-environmental tests that were specified in par. 3.2.1 of this test plan:

| <u>Test Plan Par. No.</u> | <u>Test</u> |
|---------------------------|---|
| 3.2.1.1 | Inertial Sensor Assembly Calibration |
| 3.2.1.2 | Vehicle/PSE Hookup, Conditioning, and Pre-Power Tests |

- 3.2.1.3 Vehicle Power-on Tests
- 3.2.1.4 Guidance Computer Self-Checks
- 3.2.1.6 Hydraulic System Tests
- 3.2.1.8 Engine Start/Shutdown Redundant Wiring Test
- 3.2.1.15 Simulated Launch-Readiness and Flight Test
(same, except that the propulsion system
simulator is not used)

In addition to the tests specified above, the DACS H/S heads (as applicable to mission requirements) shall be tested to verify integrity of pressure retention. The test methods and requirements will be similar to those specified in the following paragraph of LMSC Specification 1419628:

- 4.4.2.3.1.4 Head Pressure

3.2.5 Vehicle Engineering Buy-Off (EBO)

Subsequent to the final simulated flight test, the vehicle assembly shall be subjected to Engineering buy-off (EBO). The EBO meeting is chaired by the Program CSE. Launch Base Product Assurance may have a representative present during this procedure.

Following EBO, the vehicle assembly shall be wrapped and made ready for program/customer presentation.

3.2.6 Program/Customer Presentation

The vehicle complete kit shall be subjected to final acceptance procedures upon completion of manufacturing, testing, and cleaning operations. This activity is directed by Product Assurance and includes a final inspection and program/customer presentation. Launch Base Product Assurance may have a representative present during this final vehicle acceptance proceeding.

4.0 PREPARATION FOR DELIVERY

Preparation of the vehicle complete kit (vehicle assembly and launch base installed items) for storage or shipment between Sunnyvale facilities and the launch base shall be in accord with the requirements of the Agena tug detail model specification and will include the following:

- a. Excessive handling of the vehicle assembly removable doors is to be avoided. Refer to the vehicle service and flight-readiness document for ground handling restrictions.
- b. Care shall be exercised in handling the ISA. The original shipping container (or a similar one) shall be used for transporting the unit (when not in vehicle) between facilities.
- c. The engine nozzle cone extension shall be installed.
- d. Nonflight and recyclable items required to be installed for shipment shall be installed as required by LMSC Drawing 1390139.
- e. The HPP shaft seal breather plug and the HPP low-pressure overfill valve cap shall be installed.

Section 5
LAUNCH BASE TEST PLAN

Section 5
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DEFINITION OF TERMS AND ABBREVIATIONS

| | |
|---------|---|
| ACG | Attitude control gas |
| ACS | Attitude control system |
| AGE | Aerospace ground equipment. Ground support equipment. |
| AGS | Ascent guidance system. Refer to ISA and to guidance packages. See also ACS and DACS. |
| BAC | Bell Aerospace Co. Agena engine contractor |
| BTL | Bell Telephone Labs |
| COMPATS | Compatibility testing. Agena vehicle integrated systems test conducted at the launch base to verify compatibility of GSE. Test conducted preliminary to a system test with a mated payload. |
| CR | Cathode ray (TV) |
| Cradle | Vehicle-supporting cradle for supporting Agena and payload in ground tests and for interfacing with orbiter in payload bay |
| DACS | Dual attitude control system |
| DMS | Data management system (shuttle) |
| D-timer | Agena onboard programmed sequence timer |
| EMC | Electromagnetic compatibility |
| EMI | Electromagnetic interference |
| EOS | Earth orbital shuttle |
| F/C | Flight control |
| FEDR | Failed Equipment and Discrepancy Report |
| GC | Guidance computer |
| GFE | Government-furnished equipment |
| GSE | Ground support equipment (for either shuttle or Agena) |
| GTU | Ground test unit |
| HCV | Helium control valve |
| He | Helium |
| HPP | Hydraulic power package |
| IR | Infrared |
| IRFNA | Inhibited red fuming nitric acid. Agena propellant oxidizer |
| IRP | Inertial reference package |
| ISA | Inertial sensor assembly |

DEFINITION OF TERMS AND ABBREVIATIONS
(cont)

| | |
|------|---|
| KBPS | Kilobits per second |
| LAC | Lockheed Aircraft Corporation |
| LMSC | Lockheed Missiles & Space Company, Inc. |
| MCF | Maintenance and Checkout Facility for shuttle preflight |
| N/A | Not applicable |
| NPSP | Net positive suction pressure |
| Ox | Oxidizer |
| PCM | Pulse-code-modulation telemetry |
| PIV | Propellant isolation valve(s) |
| P/L | Payload. Agena payload refers to mission-oriented equipment attached to forward end of Agena. Shuttle payload refers in limited sense to combined Agena and Agena P/L; in general sense, to all onboard equipment and personnel chargeable to P/L |
| PPF | Payload Processing Facility |
| PPMV | Parts per million volumetric |
| psig | Pounds per square inch gage |
| PSMT | Propulsion system pressurization monitor tool (Agena) |
| pyro | Pyrotechnic |
| RF | Radio frequency |
| SCN | Specification Change Notice |
| SIU | Shuttle interface unit. Agena/payload service panel in orbiter cargo bay. Provides electrical and dump line interface between Agena and orbiter systems (data bus, payload command/control console, and TLM encoder) |
| SPS | Secondary propulsion system |
| TBD | To be determined |
| TLM | Telemetry |
| TPCN | Test Procedure Change Notice |
| TV | Television. Cathode ray monitor/readout |
| UDMH | Unsymmetrical dimethylhydrazine. Agena propellant fuel |
| VDC | Volts direct current |
| VST | Vehicle system test. Agena integrated test |
| WECO | Western Electric Company |

1.0 OBJECTIVE

This plan defines the major operational, servicing, test and checkout requirements to be performed on the earth orbital shuttle/Agena tug complete assembly at the launch base in preparation for launch. It was prepared under the Shuttle/Agena Compatibility Study contract (NAS 9-11949); specific response is to that portion of Task 1 of the contract work statement restated as follows:

Checkout and preflight operations will be examined to insure full provisions are included for performing realistic integration of the space propulsion stage with the planned shuttle configuration and operational sequence. Mission elements to be considered will include: checkout, handling, tanking, payload integration, insertion into the shuttle, interface validation, countdown, launch, abort. AGE and facility requirements will be identified.

Also included with reference to Task 2 are factory-to-launch sequences and suggested timelines.

The objective of the test program at the launch site is to demonstrate the flight readiness of the vehicle prior to launch and while mated with the Agena support cradle and integrated with the launch facility test equipment.

Test activities include receiving inspection, mating the Agena with the cradle, and functional testing across Agena/payload and orbiter/Agena interfaces. Orbiter/Agena systems compatibility will be determined through vehicle performance in simulated flight-programmed integrated tests. During the tests the Agena, its payload interfaces, its orbiter interfaces, supporting GSE, and remote ground-based stations and associated procedures required to support preflight and flight operations will be demonstrated. The necessary orbiter/Agena prelaunch tests indicated in this test plan shall be performed as well as the servicing and operations defined in the LMSC vehicle service and flight-readiness document. A prelaunch audit of the Agena vehicle and supporting documentation shall be performed as a customer acceptance function to assure that all established program and engineering requirements have been met.

Shuttle/Agena launch base activities will be conducted by program test teams consisting of NASA, LMSC, and payload contractor personnel. NASA will maintain cognizance over and monitor Agena tug activities. Payload contractor personnel will provide technical direction for payload functional activities. The LMSC Chief Systems Engineer through his deputy, the LMSC test team leader, will provide technical direction for Shuttle/Agena prelaunch tests and installations. The LMSC test team shall provide analysis of Agena tug test results.

The plan includes a contingency for up to 14 days storage in a flight-ready status, plus 4 days for mating and checkout with the shuttle orbiter and support of the shuttle countdown.

2.0 APPLICATION

This Launch Base Test Plan presupposes:

- An integrated flight-ready Agena (except for minor installations to accommodate shipping constraints)
- A flight-ready Agena vehicle-supporting cradle
- A flight-ready shuttle orbiter with installed and checked-out Agena interface equipment on board
- A flight-ready payload ready for installation on the Agena
- Available and checked-out ground support equipment (for both the Agena and the shuttle) ready to support testing and launch operations as required

This plan covers Agena tug and Agena-directly-related activities from receipt of the Agena at the launch site through test, integration, and checkout activities up to shuttle launch. It does not address the possibility of simultaneous launch base operations on more than one Agena tug at a time. However, with the short shuttle turnaround time, the possibility of storage of flight-ready payloads, and the further possibility of alternate payload availability, some duplication of facilities and equipment and some integration of multiple operations may be required.

Wherever an LMSC document referenced in this test plan has been superseded by an LMSC approved change, revision, or cancellation and replacement, the superseding document shall apply unless noted to the contrary in this plan or by note in the reference. However, in the event of any conflict between a referenced document and this plan, the provisions of this plan shall apply.

3.0 TEST OPERATIONS CONCEPT

This Launch Base Test Plan for the Agena tug is especially designed to take advantage of the inherent operational flexibility of the Agena and to make maximum use of existing procedural concepts and extensive Agena experience. Planning ground rules are as follows:

- Complete vehicle checkout and test prior to shipment from the LMSC Sunnyvale factory
- Maximum decoupling from scheduled Agena payload availability
- Maximum decoupling from the shuttle orbiter schedules

Further considerations:

- Agena must be vertical for propellant loading.
- Propellant will be loaded before the Agena is installed in the orbiter payload bay.
- Present plans call for not more than 16 hours for Agena mating and checkout with the shuttle on the fourth day before launch.
- Agena and orbiter will be mated in the horizontal attitude.
- Ability to store a flight-ready Agena/payload with propellant loaded for up to 14 days is assumed.
- Agena will not be readily accessible when the shuttle is on the launch pad

The sequence of test operations developed in this plan is based upon the factory-to-pad concept. Under this concept, all Agena systems on each vehicle are checked out and proven by a system test in which an integrated test tape simulates flight sequences; and each integrated Agena vehicle is accepted as flight-ready at the factory (with minor exceptions to permit shipment).

With this as a basis, this Launch Base Test Plan features the following building-block concept for the Agena tug. The Agena is integrated through four higher-order steps leading to shuttle launch. Each step is followed by a system test run to prove all systems compatible and functioning through each new interface. These four steps for the Agena tug are:

1. Assemble the checked-out Agena with the launch base ground support equipment and prove compatibility with the integrated test tape (COMPATS).
2. Install the Agena in the vehicle-supporting cradle and the payload on the Agena and use test and flight tapes (system test) to prove interfaces.
3. Prove Agena tug and orbiter RF compatibility for post-deployment command, control, and telemetry (RF check simulating post-deployment).
4. Mate Agena with shuttle by installing in orbiter payload bay and simulate flight by read-in/read-out through orbiter/Agena plug-in interfaces.

This building-block approach assures maximum reliability and proof of systems with minimum delay should an interface problem be revealed.

There is a clear delineation of interface steps and yet maximum flexibility for alternatives should scheduling problems arise. For instance, RF checks between the Agena and a supporting tracking station or similar remote ground station are planned to occur in Step 1 above, but can as readily occur in Step 2 and conceivably could be delayed to Step 3. In a more gross sense, under some circumstances it may be desirable to combine Steps 2 and 3.

By starting with a fully checked out vehicle from the factory, launch base scheduling flexibility is maintained through minimal vehicle activity at the launch site. High reliability confidence is maintained because:

- Launch base operations start with a tested, checked-out, and flight-simulation-proven vehicle.
- Each new integration or added interface at the launch site is followed by checkout to prove flight-readiness has not been compromised.
- Each such checkout during launch base preparations uses flight-simulation techniques and again exercises flight-ready Agena systems and subsystems.

4.0 RESPONSIBILITIES

The LMSC Agena tug Chief Systems Engineer will have overall LMSC responsibility for technical and engineering activities on the Agena tug. This includes responsibility for authorizing any parts removal or replacement, any demating from the cradle or tank supporting rings, and any changes or deviations from this plan or approved procedures.

The LMSC launch base test team leader under the CSE shall be responsible for all LMSC testing and LMSC testing support of NASA activities at the launch base. He shall confer with the LMSC Chief Systems Engineer in Sunnyvale, as required.

The LMSC Quality Control organization shall monitor all launch base Agena testing, certify compliance with approved procedures up to the start of final countdown, and verify compliance with the quality assurance provisions of LMSC specifications.

The LMSC Space Systems Division Logistics organization shall be responsible for recycling nonflyable items delivered with the Agena tug and supporting cradle.

The NASA shuttle prelaunch operations personnel, Maintenance and Refurbishment Facility, and supporting contractors shall be responsible for flight readiness of the SIU, the vehicle-supporting cradle, and the various shuttle flight and ground systems between the SIU to and including the shuttle ground station.

NASA shall be responsible for installing and mating the Agena (with cradle) to the orbiter and for scheduling checkout activities after mating.

LMSC shall be responsible for determining Agena command sequences and timing and for evaluating telemetry readout.

LMSC shall be responsible for monitoring status prior to installation in the orbiter.

NASA shall be responsible for monitoring status during and after orbiter installation.

NASA shall be responsible for safety at the launch site.

The payload contractor will be responsible for all tests and operations applicable to the payload hardware.

5.0 MILESTONE SCHEDULE

| <u>Sequence</u> | <u>(L-Days) Start</u> | <u>Activity</u> | <u>Allowed Elapsed Time</u> |
|-----------------|---------------------------|--|-------------------------------------|
| 1 | L-27 | Receiving Inspection | 1 day |
| 2 | L-26 | Vehicle Alignments Check | 5 days |
| 3 | L-21 | Compatibility Checks (COMPATS) | 2 days |
| 4 | L-19 | Leak Checks (ACG and Propulsion System) | 3 days |
| 5 | L-16 | Cradle Checkout & Mate | 3 days |
| 6 | L-13 | Payload Mate | 1 day |
| 7 | L-12 | Battery Activation (parallel operation – see note) | (4 days) |
| 8 | L-12 | System Test (with cradle & P/L) | 2 days |
| 9 | L-10 | PIV Leak Check | 1 day |
| 10 | L-9 | Engine Servicing | 1 day |
| 11 | | Pyro Installation | |
| 12 | L-8 | Battery Installation | 1 day |
| 13 | L-7 | Propellant Loading | 1 day |
| 14 | L-6 | Pressurization | 1 day |
| (noted) | | Storage (if applicable) | noted |
| 15 | L-5 | RF Check Simulating Post-Deployment | 8 hr |
| 16 | L-4 | Orbiter Mate | 8 hr |
| 17 | L-4 | Post-Mate Checks | 8 hr |
| 18 | L-3 | Status Check & Countdown Monitor | N/A |
| 19 | L-30 min. | Optical Alignment Check | |

NOTES:

1. Battery activation (Item 7) is a parallel operation not directly involving the vehicle. It must be completed before battery installation (Item 12). Storage in a refrigerator (standard procedure) allows activation to be advanced or installation delayed without penalty.
2. If payload is not available (Item 6), dry storage (factory procedure) shall start after completion of Item 5. System test (Item 8) shall not proceed without payload.
3. Storage can be inserted into the sequence at any point after Item 5 and before Item 15 when orbiter shall be available. Storage and storage removal activities (combined) shall be 14 days maximum if initiated after propellant loading (Item 13) to provide 4 days for shuttle mating and launch activities (18 days total).
4. RF checks simulating post deployment (Item 15) can be conducted as a part of orbiter checkout.

6.0 CONFIGURATIONS

The following generally defines the conditions upon which this plan is premised.

The Agena configuration is compatible with the following situations:

- Enclosed in orbiter bay – no fairing
- Supported in orbiter by a vehicle-supporting cradle
- Handled and installed in the orbiter while in a horizontal position and with propellant loaded. Requires propellant tank supporting rings in addition to the cradle.
- Is to be deployed from orbiter while the latter is in orbit. Orbiter has prelaunch checkout capability.
- No commands from Agena to booster or orbiter
- No destruct system
- Inactive during ascent except for telemetry and guidance system
- Powered from orbiter until deployment

The Launch Base Test Plan is based on the assumption that the Agena has been modified as follows:

- Modifications to maintain an inert atmosphere within the engine after propellant loading and subsequent to drying the engine and fill lines. The engine cannot be permitted to breathe. This in part may require propellant isolation valve modifications.

- Addition of test probe points at the propellant line disconnect retraction mechanism on the cradle. These are to verify cradle-shuttle interface unit circuits to the retraction mechanism after orbiter mating without activating the retraction mechanism or disconnecting the quick-disconnects.
- If a horizon sensor is installed, an IR source is required to check the sensor in the absence of the usual cover with IR.
- PIV modifications shall provide a means for leak-checking dump lines. At present, pressure may not be applied to the inlet port with the PIV in closed position.
- Ports and plugs are required next to the engine propellant pressure sensors to permit drying of the propellant lines after propellant loading. Present procedures removing the pressure sensors are not permissible after checkout.

Prior to delivery of the Agena vehicle to the launch base:

- All flight hardware (parts, components, etc.) shall have been acceptance tested prior to delivery to the customer or leaving the LMSC Sunnyvale plant.
- Vehicle final inspection, system tests, and acceptance procedures shall have been completed.

When ready to accept Agena installation the orbiter shall be configured as follows:

- A shuttle interface unit (SIU) and Agena/Payload Service Panel shall be installed and previously checked out with an Agena interface simulator. The SIU shall provide the only electrical (power, command, control, telemetry) and propellant dump line connections between the Agena/cradle and the orbiter (Fig. 5-1).
- Cradle attach points shall have been verified for location and alignment.
- Permanently installed orbiter payload bay propellant leak sensors shall have been installed and checked out independently of leak sensors on the Agena.
- A payload control console in the orbiter shall have the capability of:
 - Receiving and recording Agena command messages from the ground through the shuttle ground station and communications link
 - Transmitting via hard connections before deployment and via RF after deployment commands to the Agena both from the ground (as above) and shuttle-originated command tapes
 - Monitoring Agena safety status data and deployment status
- A shuttle data link to the ground station shall be capable of recording and transmitting the entire Agena telemetry link to the ground station from the Agena via the SIU and via Agena RF after deployment.

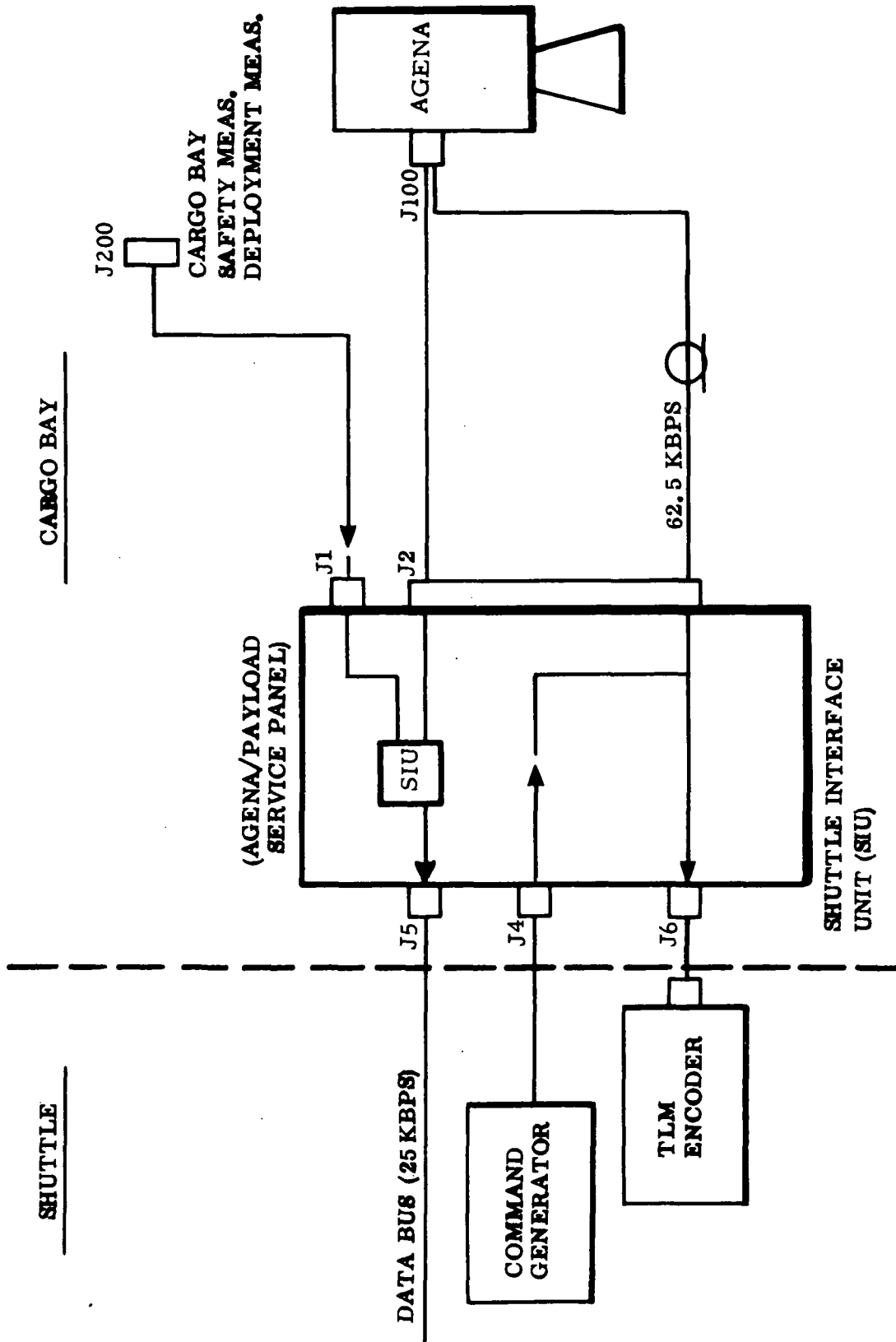


Fig. 5-1 Agena/Orbiter Electrical Interface

The shuttle ground station shall have the capability of receiving, separating, and recording Agena telemetry and of transmitting Agena command tapes.

Vehicle-supporting cradles for the Agena are a shuttle reusable flight equipment item. They shall be supplied to the Payload Processing Facility in a checked-out, flight-ready condition with all attach points aligned and all plug pin connections straight and ready to receive mating parts.

7.0 FACILITY AND SUPPORT REQUIREMENTS

Facility and support requirements are tabulated below:

- a. Agena facility support at the Payload Processing Facility will be required in accord with the Facility Requirements Plan (Reference: LMSC-A971627 or superseding document).
- b. Agena ground support equipment (GSE) and handling capabilities will be required in accord with the Aerospace Ground Equipment Plan (Reference: LMSC-A971603 and LMSC-A991366, Section 6, or superseding documents).
- c. The Agena will be offloaded from the delivery aircraft and moved to the Agena tug payload processing facility with equipment normally available at the launch site. Slings will be required.
- d. A standard Agena handling dolly and work fixture will be required to hold and move the Agena during alignment checks and before mating with the cradle.
- e. The Agena vehicle-supporting cradle (a flight article and Agena/orbiter mechanical interface structure) will be required for handling and testing the Agena prior to orbiter mating.
- f. An orbiter cradle dolly with attach points identical to the orbiter payload bay attach points will be required for handling and moving the Agena after Agena-cradle mating.
- g. Propellant tank supporting rings (associated with the cradle) will be required to support loaded Agena propellant tanks whenever the Agena is moved off vertical.
- h. A standard Agena ground test unit (GTU) will be required. The GTU shall be required to provide Brayco fluid to the hydraulic power package (HPP) motor at a flow rate of 2 gpm at 500 psig maximum pressure differential. A hydraulic ground test unit will also be required.
- i. Equipment will be required to verify proper turbine exhaust duct alignment and other alignments. This equipment is portable and can be utilized in any area with solid flooring.

- j. A vertical test fixture will be required to accommodate the Agena/payload stackup. If the Readiness Area (described below) is used for payload mating, presumably the equipment could be combined.
- k. A payload interface simulator will be required for COMPATS testing. This could be the same equipment as used in factory system tests.
- l. Electrical adapters and plug connections duplicating the Agena-cradle interface will be required for tests prior to Agena-cradle mating.
- m. An Agena tug Readiness Area* easily accessible to the shuttle launch pad will be required at the launch base. This Readiness Area could be the Payload Processing Facility (PPF), a safe area adjoining the PPF, or another area between the PPF and the orbiter mating area. It will duplicate facilities normally found at a launch pad where Agenas are serviced. The Readiness Area will provide facilities for inspection, assembly, checkout, test, erection, storage, fueling, and all other activities in preparation for installing the complete shuttle payload in the orbiter bay. The Readiness Area will be located or equipped so that RF checks (possibly with reradiating equipment) can be made between the Agena and both a tracking station or simulator and the orbiter. It will also have all safety facilities for handling and installing propellants, pyrotechnics, and pressurization equipment for loading, storing, and handling a fueled Agena. This includes propellant fill and vent lines and high-pressure gas lines in an umbilical-like tower. Fuel and oxidizer tanks (permanent or mobile) will be included.
- n. A vehicle command console and a PCM telemetry processing facility will be required. Agena telemetry data will be processed by the computers, displayed for realtime observation, and compiled for post-test data analysis.
- o. Propellant leakage sensors (sniffers) and an emergency dump control shall be required to effect emergency propellant dumping with the Agena loaded in the Payload Processing Facility Readiness Area before, during, and after storage. This can be similar to or the same unit as used in conjunction with the shuttle GSE ground station.
- p. A clean room in the Payload Processing Facility and/or a clean tunnel at the Readiness Area will be required for environmental control of the Agena and payload.
- q. Air-conditioning equipment will be required for the Agena at the Readiness Area for maintaining (TBD) temperatures after propellant loading and during storage.
- r. A shuttle interface unit simulator shall be required for system test conducted after Agena/payload and Agena/cradle matings and before installation in the shuttle payload bay.

*Pad 13 at Cape Kennedy satisfies requirements for an Agena readiness area.

- s. A propellant system drying unit consisting of a selector valve, a vacuum source and aspirator, and lines to connect to the Agena cradle and to the propellant storage tanks shall be required for drying the engine and propellant lines after loading. This is shown schematically in the Propellant Loading section of this plan.
- t. Environmental and temperature control in the orbiter bay will be required to (TBD) requirements.
- u. The Agena will require the orbiter as a power source after mating and throughout integrated testing and the launch operations.
- v. Fixtures, platforms, and access will be required to effect final optical alignment while installed in the orbiter at launch minus 30 minutes.
- w. Availability of the orbiter payload control station and of the shuttle GSE will be required immediately before and after Agena-orbiter mating for RF and after-mating command-in/readout checks.
- x. Photographic support will be required to record critical installations and matings such as pyrotechnic, payload, etc.
- y. Portable pressure and safety monitoring equipment shall be required during transporting and mating operations with propellant loading and/or pressurization of the Agena completed.

8.0 POLICIES AND CONSTRAINTS

This test plan shall be implemented by detailed procedures and supporting documents approved by the LMSC Chief Systems Engineer. This detailed documentation shall be reviewed for applicability and updated if necessary for each model of the Agena tug. Application of test procedures shall be called out by vehicle model serial number.

8.1 SAFETY GUIDELINES AND CONSTRAINTS

Safety precautions and good safety practices shall be followed at all times and in every respect in the implementation of this plan. Established NASA and Lockheed safety manuals and procedures shall be reviewed and incorporated wherever applicable when detailed procedures are developed from this plan.

8.1.1 Crew Access

The loading of propellants, high-pressure gases, and explosive devices in or on the Agena shall be completed, and proper venting, pressure control, and absence of leaks shall be established before flight personnel are allowed to board the orbiter or booster.

8.1.2 Safety Monitoring

All safety parameters of Agena subsystems will be continuously monitored* after the subsystem has been activated or loaded. The safety parameters in this category include the following:

- Fuel tank temperature
- Fuel tank pressure
- Oxidizer tank temperature
- Oxidizer tank pressure
- Fuel tank/oxidizer tank differential pressure
- Helium sphere pressure
- Nitrogen sphere pressure
- Main bus voltage and current
- Pyro bus voltage and current
- Leak-detection sensors in the Agena
- Battery temperatures**
- Environmental temperatures in the clean tunnel or orbiter payload bay, as applicable

In addition, leak-detection sensors in the orbiter payload bay shall be monitored by the shuttle and shuttle support crew while the Agena is installed in the orbiter.

*Continuous safety monitoring shall be construed as continuous recording with alarms as well as continuous monitoring by personnel.

**Battery temperatures require safety monitoring only once every 24 hours.

Safety monitoring shall be continuous after propellants are loaded and/or tanks pressurized. Agena GSE shall remain hooked up and instrumentation power applied during storage and moving before installation in the orbiter. Power and monitoring shall be via orbiter systems after installation in the orbiter.

8.1.3 Propellant Loading

The Agena propellant tanks hold approximately 4,000 lb of fuel (unsymmetrical dimethylhydrazine – UDMH) and 10,000 lb of oxidizer (inhibited red fuming nitric acid – IRFNA). These fluids are hypergolic under certain conditions of pressure, temperature, and mixture ratio. Leaks or spills must be avoided and proper handling and storage procedures must be employed to minimize hazards to the payload, shuttle, and ground and flight personnel.

During and after propellant loading, personnel access to the area shall be restricted and stringent safety precautions and procedures effectively applied. Propellant loading procedures described in this plan shall be followed rigorously to prevent spillage or bulkhead reversal and to assure proper sequencing and venting.

8.1.4 Propellant Dumping

The Agena tug shall be loaded with propellant and oxidizer in the Agena Readiness Area, which is a designated safe area as part of, alongside, or associated with the Agena tug Payload Processing Facility. This loading activity shall occur normally before mating and installation of the Agena in the orbiter. The propellant and oxidizer fill lines shall remain attached after loading to provide a rapid dump capability in an emergency.

Propellant emergency dumping provisions shall be operable with the Agena in the vertical position while the Agena is:

- Being loaded and/or tested in the Readiness Area
- Undergoing storage while loaded (also in the Readiness Area)
- Mated to the orbiter and installed in the orbiter payload bay when the orbiter is in the vertical position
- Installed in the orbiter and the shuttle booster/orbiter is on the launch pad

Propellant dumping provisions cannot be maintained:

- While the Agena is being moved from the Readiness Area to the mating area or to the launch pad
- When the Agena is not vertical (as in a horizontal installation and mating with the orbiter)
- When the orbiter is moved with the Agena on board

When the Agena is in the orbiter, the dump lines are connected through the orbiter payload bay dump hardware. At those times, control of the dump hardware is through the orbiter data bus; payload monitoring and initiation of the dump sequence shall occur at any of the following shuttle stations:

- Payload controller's console
- Orbiter cockpit
- Shuttle GSE (Note: This is the only control during periods when the shuttle crew is not on board nor at station.)

Propellant dumping sequences shall be as specified in this plan under par. 9.14 in order to prevent tank bulkhead reversal and provide dumping pressurization.

8.1.5 Pressurization Safety Requirements

Propellant tank pressures shall be monitored and controlled at all times, in accordance with the requirements of the vehicle service and flight-readiness document and propellant loading and propellant dumping requirements specified herein and in supporting specifications and procedures to prevent reversal of the common bulkhead between the oxidizer and fuel tanks. Fluctuations in ambient temperatures and pressures or variations in tank pressures must never be allowed to cause the aft (oxidizer) tank pressure to exceed the forward (fuel) tank pressure. Tank pressures shall never be less than atmospheric pressure. Also, tank pressurization procedures must be rigorously followed.

The following pressurization safety requirements shall be observed:

- a. Pneumatic pressure conditions shall be in accord with LMSC Safety Standard 5.6.
- b. The following precautions shall be observed when using the gas fill checkout coupling:
 - (1) If it is required that the checkout coupling be maintained in the open position without a nitrogen actuation source connected to prevent inadvertent depressurization of the vehicle, the service fluid source line or service fluid port caps shall not be removed during this open position.
 - (2) To permit closure of the checkout coupling from the condition described above, a 300-psig nitrogen actuation source shall be connected to the actuator port of the checkout coupling.
 - (3) When the nitrogen sphere is pressurized to 1500 psig or higher, the gas fill coupling ground half, when connected to the air half, shall be pressurized to within 600 psi of the nitrogen sphere pressure before actuating the poppets to the open position.

8.1.6 Pyrotechnic Devices

All pyrotechnic devices shall be properly protected to prevent actuation from electromagnetic and electrostatic sources. Electrical wiring shall be adequately shielded and all components grounded. Activation of a pyrotechnic device in the shuttle bay shall require deliberate intended action on the part of the shuttle crew.

8.1.7 Equalization of Ground Potential

The Agena tug with propellants loaded shall be adequately grounded at all times during handling, storage, transportation, and any mating processes in accord with long-established good operating practices involving flight equipment and vehicles. Before Agena mating with the orbiter, each vehicle shall be grounded – first separately, and then also with a common ground. Similar procedures shall be followed:

- During mating of the booster with the orbiter with a loaded Agena on board
- When connecting to GSE or other equipment
- During any removals or installations involving the Agena either directly or indirectly (such as a delayed interchange of Agena payloads)

Capability to equalize ground potential between the Agena and the orbiter before electrical circuit interconnection is to be provided in the orbiter system design.

8.1.8 Electrical Power Application

The following conditions shall be observed in the application and removal of electrical power:

- a. During the testing period at the launch base, vehicle power shall not be applied without LMSC test team approval.
- b. Caution shall be exercised in applying electrical power to the vehicle or components. Low-voltage application or feedback to the electrical bus may cause damage to equipment.
- c. The vehicle power transfer switch "on" and "off" control voltage shall not be applied simultaneously. The switch shall not be cycled on and off more than once within a 1-minute period. The actuation power shall be 24 VDC, 8 amperes minimum at the GSE interface connector.
- d. Power shall be off when connecting and disconnecting vehicle components or harnesses.

8.1.9 Pneumatic Pressure Safety Constraints

LMSC Safety and Industrial Hygiene Standard 5.6 is paraphrased as follows: With certain exceptions, no pressure vessel or system shall be pressurized above the maximum personnel exposure pressure, which is 25 percent of the design burst pressure, without specific written approval of the cognizant LMSC safety engineer. However, the LMSC safety engineer approval shall never be given for planned personnel exposures for pressures exceeding 50 percent of the design burst pressure.

8.2 OPERATIONAL AND TESTING CONSTRAINTS

In addition to the preceding safety guidelines and constraints, the following operational constraints shall be observed during launch base operations and testing:

- All ground support equipment (GSE) shall be checked out and demonstrated to be ready to support tests before being applied to the vehicle or to vehicle testing.

- Agena tanks must be supported by supporting rings attached to the Agena tug cradle when the Agena is not in the vertical position (due to anticipated crane acceleration loads during handling, especially with loaded tanks).
- All testing and servicing shall comply with the vehicle service and flight-readiness document (LMSC-14208342) or superseding document for the designated vehicle model.
- The sequence of operations covered by the plan shall be in accordance with the Readiness Days Checklist which will be prepared to integrate all vehicle ground support equipment and facility activities.
- The activities will be scheduled by the launch base Official Integrated Schedule which will be in accordance with the master schedule.
- During launch base testing, the requirements of the Launch and Hold Limitations Specification (LMSC-1419788) or superseding document shall apply.
- Throughout the entire test sequence, maximum care shall be taken to assure that the tests previously conducted will not be invalidated by subsequent tests or operations. The provisions of LMSC Specifications 1419628 and 1419778 or superseding documents shall apply.
- During tests or assembly operations, all open electrical connectors shall be protected by protective caps in accordance with applicable specifications and LMSC Drawing 1388222.
- At no time shall test probes be used or inserted into connector sockets, since severe damage to contacts and insert material may result. A mating connector with outgoing test leads shall be the preferred method. A mating pin with outgoing test leads may be used when specifically approved by the Chief Systems Engineer or his representative.
- Disconnecting and reconnecting of electrical connections shall be minimized to prevent bent pins.
- Protective covers or plugs shall be installed to protect vehicle equipment exits, ports, and disconnects as indicated in LMSC-1388222, "Non-Flight and Recyclable Items, Installation and Removal," or superseding document during nonoperating periods.
- The propulsion pneumatic attitude control and the helium high-pressure system shall be kept sealed and pressurized during nonoperating periods to meet the requirements stated in LMSC Specification 1419628 or superseding document.
- The following process bulletins and LAC procedures shall be adhered to in order to prevent contamination, control moisture, and protect thermal control surfaces:
 - PB6, "Amendment – Cleaning of Propellant Tanks"
 - PB7, "Moisture Control for Corrosion Prevention"
 - LAC 3150, "Contamination Control of Fluid Systems and Associated Components and Parts"

- Upon completion of any programmed system acceptance test, vehicle equipment such as programmers, single-action valves, etc., shall be configured to support the next operation or test or for vehicle launch.
- Handling, shipping, and storage of vehicle equipment shall be as specified in LMSC Specifications 1419628 and 1419778 or superseding documents.
- Detailed definition of telemetry instrumentation measurement priorities, including launch countdown requirements, are indicated in the Instrumentation Schedule, LMSC-A938180, and the Launch and Hold Limitations Specification, LMSC-1419778, or equivalent document for the specific vehicle under test.
- All transducers shall have been calibrated and inspected at the vendor site against the applicable engineering specification. LMSC report A928111 specifies the required handling of transducers by LMSC. This includes a calibration check of the transducer and disposition of data. Upon installation, the transducer calibration data are identified according to installation and become part of the Vehicle Calibration Report.
- Instrumentation status data shall be available prior to RF checks. The program office shall transmit to the Mission Control Center the following information for each vehicle: (1) the latest instrumentation schedule and calibration book changes, and (2) any telemetry or instrumentation points or measurements that are not expected to yield valid data during flight.
- Flight constants tape is invalidated by (1) change in ISA or components, or (2) delay in use beyond 120 days after input on constants.
- All testing and other operations specified (except final countdown) shall be witnessed and certified by LMSC Product Assurance (Reference: LMSC Space Systems Division Procedure O-107).
- The pneumatic system shall be pressurized with nitrogen gas and maintained between 15 and 150 psig during all handling, standby, and non-operating periods.
- To minimize the possibility of an explosive mixture occurring in the gear case, the fuel pump shaft is sealed from the gear case with a primary sliding ring-type seal and a single lip seal; the oxidizer pump is sealed with a primary seal and a double lip seal. To provide maximum protection against acid leaking into the gear case, this double lip seal is pressurized with low-pressure nitrogen gas, which would force any leakage past the primary seal to flow into the overboard drain. When the engine is exposed to propellants, the nitrogen pneumatic regulator shall be in the high mode and the lip seal valve shall be open at all times so that the lip seal cavity can be pressurized. However, after the engine is dried out, the lip-seal pressure control shall be returned to the closed position (Reference: vehicle service and flight readiness document, LMSC-1420834, or superseding document).

- If any nitrogen pneumatic lines are disconnected, a positive inlet pressure of 2 psig minimum shall be maintained to the system. All open lines and ports shall be capped and plugged immediately (Reference: LMSC-1420834 or superseding document).
- At no time shall the nitrogen pneumatic system be allowed to "breathe" atmosphere. Blowdown by thrust valves shall be performed at low flow rates to avoid excessive cooling and moisture condensation. During depressurization, the inlet pressure shall be maintained at a level equal to or greater than the outlet pressure (Reference: LMSC-1420834).
- The nitrogen high-pressure ground-connection coupling shall not be connected to the vehicle unless the ground-half fluid service side is pressurized to not less than one-half of vehicle sphere pressure (Reference: LMSC-1420834).
- When the gas storage spheres of the vehicle are vented, the service fluid line of the ground half of the gas-fill valve shall be pressurized to within 600 psi of the pressure in the sphere to be vented before pressurizing the actuation port of the ground half (Reference: LMSC-1420834).
- All program and GFE hardware shall be controlled and dispositioned in accordance with LMSC standard practices and program-approved directives. A logistics flow document shall define conditions for the removal and corrective action to be taken for nonconforming government-furnished equipment (Reference: LMSC-A938388).
- The acceptance of "use-as-is" or "acceptable-to-Engineering" dispositions on out-of-specification conditions on functional flight equipment is not permitted. Except in rare instances, the only acceptable disposition will be a change in specification. If Design Engineering management wishes to approve a specific out-of-specification condition, the specific reason for approval must appear on the failed equipment and discrepancy report (FEDR) with the signature of the responsible person. A full, concise justification acceptable to and approved by the Chief Systems Engineer on the FEDR is required.
- Modules or components shall be repaired only at the appropriate pre-designated repair station.
- If a component is known or suspected to be discrepant and no manufacturing or logistics spare is available, opening of the component and the making of repairs is authorized at the discretion and responsibility of the Chief Systems Engineer. The responsible equipment engineer shall be informed of the action taken on the opened component and shall witness the repair. A FEDR shall document the lack of a replacement, the failure determined, and the repairs effected. A FEDR shall be written for documentation purposes each time a component is opened, even if no failure is discerned. Reacceptance testing of the repaired component is required. No repairs of engine hardware are allowed. Purchased parts shall be repaired by the supplier. Repair or modification to government-furnished equipment (GFE) shall be in accordance with LMSC Bulletin G-58.

8.3 TIME-RELATED CONSTRAINTS

The maximum elapsed time that shall occur between the functions shown and vehicle launch without contractor and customer evaluation of possible risk associated with a particular extension is summarized below. The exact time limitations imposed on any one vehicle shall be reviewed for each model by serial number and specified in the Launch and Hold Limitations Specification (Reference: LMSC 1419778 or superseding document).

| <u>System or Component</u> | <u>Elapsed Time (days)</u> |
|--|----------------------------|
| MPS Engine Contamination Inspection | 365 |
| MPS Functional and Leak Test | 38 |
| MPS Launch Base Exposure | (TBD) |
| MPS Propellant Exposure | 18* |
| SPS Functional and Leak Test and Propellant Exposure | (TBD) |
| DACS Pneumatic System Functional and Static Leak Tests | 38 |
| DACS Launch Base Exposure | 38 |
| DACS High-Pressure Exposure | 18* |
| Hydraulic Control System Servicing | 38 |
| Hydraulic Control System Component Functional and Leak-Test Time | 38 |
| Hydraulic Control System HPP and Actuator Test Time Limitations | 300 |
| HPP Propellant Exposure Limitations | 18* |
| Hydraulic System Leakage Inspection | 30 |
| Battery Activation Time Limitations | --- |
| Velocity Control Assembly Calibration Time Limitations | 180 |
| Transducer Calibration Time Limitation | 180 |
| Engine Pyrotechnic Limitations | 38 |

*Allows 14 days in storage plus 4 days from storage removal to launch.

9.0 TEST METHODS

Safety and operating constraints imposed by this plan and LMSC standard operating procedures shall be observed during all phases of launch base operations, prelaunch testing, and Agena activities through countdown.

All spacecraft assembly, testing, and handling operations shall be performed under conditions where visible contamination is kept to a minimum. Visible particulate matter shall be removed from spacecraft surfaces by suitable means.

The testing program established by this Agena tug Launch Base Test Plan and the test requirements imposed by the detail specification shall be implemented in accordance with applicable LMSC Space Systems Division operating procedures.

Upon completion of any vehicle system test, the vehicle assembly equipment shall be reset to the state necessary to preclude equipment damage during subsequent testing or upon the reapplication of power. The reset will include, but not be limited to, the following:

- Computer reset
- Tape recorder off
- Engine in the shutdown mode

LMSC Quality Control shall monitor all installations, testing, and prelaunch Agena operations, certify compliance with approved procedures as posted in the vehicle logbook, and verify compliance with the quality assurance provisions of LMSC Specification 1420780, or superseding document.

No deviations from this test plan and the approved test procedures shall be permitted without authorization of the Chief Systems Engineer.

Monitoring equipment shall be connected to the equipment under test to ensure that operating and nonoperating limits are not exceeded. During testing, precautions and

operating conditions shall be enforced as specified in the following paragraphs of the vehicle service and flight-readiness document (paragraph numbers refer to LMSC document 1420834).

| <u>Par. No.</u> | |
|-----------------|---|
| 4.3.1.1 | Atmospheric Conditions |
| 4.3.1.2 | Air-Conditioning Requirements |
| 4.3.2 | Electrical Test Power |
| 4.3.3.1 | Nitrogen Source |
| 4.3.3.2 | Helium Source |
| 4.3.4 | Controlled Operating Time |
| 4.3.5 | Controlled Conditions |
| 4.3.6 | General Precautions |
| 4.3.7 | Test Instrumentation and Measurements |
| 4.3.8 | Tubing, Fittings, Instruments, and other Equipment |
| 4.3.9 | Propulsion and Pneumatic Systems Maximum Pressures |
| 4.3.8.1 | Tube Connections |
| 4.3.8.2 | Tube Replacement, Component Replacement, and Braze-Joint Repairs in Braze Plumbing Systems |
| 4.3.9.1 | General Personnel Exposure |
| 4.3.9.2 | Limited Personnel Exposure |
| 4.3.9.3 | Remote Operation |
| 4.4.2a | Propellant Tank Bulkhead Reversal Precautions |
| 4.4.2b | Helium High-Pressure System |
| 4.4.2c | Propellant System Pressurization |
| 4.4.2d | Gas Fill Checkout Coupling |
| 4.4.2e | PIV Actuation |
| 4.4.2f | Turbine Exhaust Duct Pressurization |
| 4.4.2g | Lubrication |
| 4.4.2h | Rocket Engine Seal Venting |
| 4.4.2i | Propulsion System Moisture/Salt Corrective Action |
| 4.4.2j | Engine Connections |
| 4.4.4a | Power Application and Removal |

| | |
|---------------|--|
| 4.4.4b | Main and Pyro Bus Test Conditions |
| 4.4.4c | Main Power Transfer Switch |
| 4.4.4d | Main Electrical Umbilical |
| 4.4.43 | Vehicle Plug List |
| 4.4.4f | Vehicle Structure Current |
| 4.4.5b | Hard Start of Gyros |
| 4.4.7a | Gas Contamination |
| 4.4.7b | System Pressurization |
| 4.4.7c | Thrust Valves |
| 4.4.7d | Lubrication |
| 4.4.7e | Tube Connections |
| 4.4.7f | Pressurization System |
| 4.4.7g | Gas Fill Checkout Coupling |
| 4.4.7.1.1.12 | Moisture Content |
| 4.4.7.1.1.1.3 | Test Gas Cleaning |
| 4.4.9a | Transmitter-Antenna Configuration |
| 4.4.9b | Instrumentation Measurement Compliance |

The documentation required to implement this Launch Base Test Plan shall include procedures for test preparation, test performance, and post-test operations. The detailed test specifications will specify in detail the test conditions, criteria, test sequences, instrumentation, data recording, and report requirements. Changes to the test specifications will be made by specification change notices (SCNs) and must be approved by Systems Engineering before implementation. Detailed test procedures shall be prepared by the testing organization and will be submitted for Program, Engineering, and Reliability approval prior to the start of testing. Product Assurance shall review and approve all acceptance test procedures. Changes to test procedures will be made only by a test procedure change notice (TPCN) and will require the same review and approval as the original test procedure.

During Agena tug testing and mating checkouts, a limited amount of telemetry data will be presented in real time by means of the analog and event recorders of the PCM ground station. In addition, recorders will be available for recording certain other test and environmental data. The complete telemetry data train will be recorded on magnetic tape for post-test processing and analysis.

Test data and test reports will be submitted by the testing agency to Engineering and Reliability for review and analysis. Other test support documentation to be submitted includes test logs, instrumentation lists/calibrations, test system schematics, discrepancy reports, photographs and/or motion pictures, as may be required.

All launch base installations shall be witnessed by the LMSC Quality Assurance organization. Nonflight items installed on the vehicle shall be removed and recycled as applicable in accordance with LMSC Drawing 1390139, or superseding document.

Final spacecraft installations and final spacecraft area "closeouts" shall be photographed. Specific photographic requirements shall be determined by the LMSC Agena tug Systems Engineering organization.

9.1 RECEIVING INSPECTION

The Agena vehicle assembly, launch base installation kits, and vehicle-supporting cradle shall be delivered directly from the factory to the shuttle launch base. (After the initial Agena tug flights, the previously used vehicle-supporting cradle will be received from the MCF or the Maintenance and Refurbishment Facility.)

Incoming space shuttle payloads and experiments for the launch site are received at the Payload Processing Facility. This facility is used for the checkout, test, and integration of payloads for Agena payload missions. The shuttle payload checkout concept provides maximum flexibility for the various payload requirements and separates the operational orbiter vehicle checkout from the Agena payload checkout.

Upon receipt of the Agena tug and Agena-related items at the Payload Processing Facility, a "visual only" receiving inspection shall be performed on all items. There will be no parts inspection. The inspection is made for identification, to verify that no damage was incurred as a result of transportation and that the Agena vehicle is ready for subsequent testing. All Agena items will be in a launch-ready clean condition when shipped from the factory. The wrapping paper and protective equipment shall be removed. Disassembly of vehicle systems or components will not be allowed.

The vehicle-supporting cradle, tank-supporting rings, and Agena attachment and deployment mechanisms will have been completely checked out under simulated loading and deployment conditions at the factory or at the space shuttle Maintenance and Refurbishment Facility before shipment to the Payload Processing Facility. Receiving and damage inspection shall be performed on the cradle and associated equipment.

If an Impactograph has been installed for shipment to the launch base, the Impactograph shall be removed and the tape checked. If the maximum acceleration of the vehicle exceeds the requirements specified in the LMSC Agena Model Specification, LMSC Systems Engineering shall be notified.

If inspection indicates cleaning is needed, applicable portions of LMSC Specification LAC 0170 and Section 4.4.1.2 of the vehicle service and flight-readiness document, LMSC-1420834, or superseding documents shall be implemented. All subsequent preparations, testing, and handling shall be performed within the constraints of the established cleanliness levels.

If at any time demating or parts removal or replacement are required, prior approval and direction of the LMSC Chief Systems Engineer is required.

Receiving inspection of the launch base installation kit will include a visual inspection for possible shipping damage and an inventory against applicable drawings and against the LMSC launch base installation drawing. Cure action for any shortages shall be initiated immediately by the Quality Assurance organization and the test team leader. Nonflight items used for shipping and mating shall be recycled by the LMSC Space Systems Division Logistics organization in accord with the LMSC Non-Flyable Items drawing when no longer needed during preparations for launch.

9.2 VEHICLE ALIGNMENTS

After completion of receiving inspection and before mating with the vehicle-supporting cradle, the Agena tug shall be installed in the standard Agena work dolly and vehicle alignments shall be checked to the specifications of the vehicle service and flight readiness document, LMSC-1420834, or superseding document, as follows:

- a. Verify alignment of engine and engine mounting and turbine exhaust duct.
- b. Verify alignment of gas jets.
- c. Verify horizon sensor alignment (if applicable).
- d. Verify payload mount plate alignment and physical interfaces.
- e. With Agena in a vertical position, make final alignment of the guidance sensor.

9.3 COMPATIBILITY TESTS (COMPATS)

After Agena vehicle receiving inspection and alignment checks have been completed, the Environment Room located in the Payload Processing Facility or the clean tunnel in the Readiness Area shall be prepared for the program vehicle testing. Air-conditioning balancing and dust particle count shall meet the requirements stipulated in the Launch Complex Requirements document (Reference: LMSC-A928100 or superseding document). The test vehicle on its dolly shall be installed in the test stand, checkout hardware and test console connected, the entry closed, and environmental conditioning performed.

COMPATS shall include the following testing sequence:

- a. Pre-power switch conditioning – check of switching modes
- b. Power on and warmup period
- c. RF checks
 - (1) Command
 - (2) Telemetry
 - (3) Ground Station
 - (4) Data Handling

- d. Guidance and flight control checks
- e. Checkout of power conversion equipment
- f. Payload simulator checks

COMPATS shall normally be conducted with the Agena in the vertical position after alignment checks. However, they can be conducted in the horizontal position if otherwise dictated.

Prior to the simulated flight tests, tests shall be performed to verify compatibility and interface integrity between Agena tug systems and the launch ground support equipment. The tests shall include verification of the GSE capability to control and monitor vehicle functions during preflight Agena/payload system tests and support of the shuttle mating and launch countdown. Electrical interface requirements for the payload and the shuttle orbiter shall be simulated. Antenna couplers shall be installed on the Agena antennas.

Before test power is applied to the vehicle, vehicle bus resistance checks shall be demonstrated in compliance with the vehicle service and flight-readiness document, LMSC-1420834, or superseding document. The vehicle power transfer switch shall have been cycled at least five times.

Guidance computer diagnostic checks of the guidance computer (GC) memory and input/output processor functions shall be performed. The self-checks shall be performed by programming the guidance computer from the diagnostic test tapes. Compliance with the vehicle service and flight-readiness document shall be demonstrated (Reference: LMSC document 1420834 or superseding document).

The telemetry and instrumentation systems shall be checked for transmitter output, transmission characteristics, and quality of data transmission. The tests shall be conducted using an RF coupler (antenna hat coupler). The quality of data transmission shall be evaluated from analysis of reduced instrumentation data and verification of

proper readout of the PCM telemeter calibration signals. The tests shall demonstrate compliance with the applicable requirements of LMSC-1420834 or superseding document as follows:

- Telemetry system RF power
- Transmitter center frequency tests
- Vehicle instrumentation data recovery accuracy test

Before the simulated flight test is performed during COMPATS, the guidance computer shall be programmed from the integrated test tape and the guidance and control system checked for hydraulic channel servo currents versus voltage input and pneumatic channel gains and phasing. The tests shall demonstrate compliance with the F/C hydraulic system tests, F/C pneumatic system tests, and the acceleration sensing test specified in the vehicle service readiness flight document, LMSC-1420834, or superseding document.

Simulated flight tests shall be performed as specified in the vehicle service and flight-readiness document, LMSC-1420834, or superseding document and shall include the following. With the vehicle in the COMPATS configuration as described above, a simulated flight functional event test shall be performed. The test will verify compatibility of the vehicle, GSE, software response of the vehicle to the simulated flight sequence programmed from the integrated test tape, and the vehicle-to-payload interface requirements. Command and monitor interface lines between the vehicle and the ground support equipment will be verified for proper operation, and all vehicle electrical subsystems will be exercised. Compliance with the following requirements shall be demonstrated (Reference: LMSC-1420834 or superseding document):

- Guidance computer programming for test
- Static navigation
- Simulated flight tests
- Pyro events testing

The vehicle redundant engine control circuitry shall be validated by a test sequence programmed from the guidance computer using the integrated test tape. Compliance with the requirements of the engine start/shutdown redundant wiring test as specified in LMSC-1420834 or superseding document shall be verified.

The propellant isolation valves shall be functionally tested for opening and closing times in accord with the PIV actuation closing test and the PIV actuation opening test as specified in LMSC-1420834 or superseding document. The following precautions shall be observed when conducting PIV actuation and internal leakage tests:

- PIVs shall not be pressurized at fill or outlet ports while in the closed position
- Either the fuel and oxidizer tanks shall be interconnected with a manifold that will ensure equal pressure in both tanks or the makeup pressure shall be supplied to the fuel tank through the fuel vent to prevent the fuel tank pressure from dropping below the oxidizer tank pressure. When an interconnecting manifold is used, it shall be connected upstream of the PIVs.
- Simultaneous opening and closing voltages shall not be applied to the PIVs, and the position indicator circuit shall not be shorted to ground.

9.4 LEAK CHECKS

These leak checks can be categorized as attitude control system checks, propulsion system checks, and component leak checks. All leak-check tests and measurements shall conform to the vehicle service and flight-readiness document (LMSC-1420834 or superseding document).

The pneumatic system shall be pressurized with nitrogen gas and maintained between 15 and 150 psig during all handling, standby, and nonoperating periods.

The propellant tank pressures shall be monitored and controlled at all times in accordance with the requirements specified herein and in supporting documents to prevent reversal of the common bulkhead between the oxidizer and fuel tanks. Fluctuations in ambient temperatures and pressures or variations in tank pressures must never be allowed to cause the aft (oxidizer) tank pressure to exceed the forward (fuel) tank pressure. Tank pressures shall never be less than atmospheric pressure.

9.4.1 Attitude Control System Tests

The nitrogen fill coupling of the pneumatic attitude control system shall be exercised to verify proper operation. The AGS shall be static-leak-checked at 3600 psi. Thrust

valve and regulator leakages shall be determined. The regulator shall be flow-checked; the main oxidizer pump lip seal shall be checked; the gas jet shall be flow-checked. The control system test gas shall be sampled and the moisture content verified to be within specification limits. Compliance with the vehicle service and flight-readiness document, LMSC 1420834, or superseding document and the following paragraphs shall be demonstrated.

9.4.2 Regulator Relief Valve Leakage Checks

With the pneumatic system pressurized at 1200 to 2880 psig with nitrogen and with the regulator in the high-pressure mode, leakage from the high-and low-pressure reference chamber relief valves, the outlet relief valve, and the inlet-pressure-sensitive and mode-sensitive bypass selector valves shall be determined, using a liquid displacement method, and shall not exceed the specification of LMSC-1420834 or superseding document.

9.4.3 Thrust Valve Leakage Checks

With the pneumatic system pressurized at 1200 to 2880 psig with nitrogen and with the regulator in the high-pressure mode, leakage from the thrust valve seats shall be determined, using a liquid displacement method, and shall not exceed the specification of LMSC-1420834 or superseding document.

9.4.4 Nitrogen Fill-Coupling Functional Check

Engagement shall be smooth without evidence of binding, and the fill poppet shall operate freely without evidence of stickiness or malfunction, as determined by actuation of the coupling using the ground half.

9.4.5 Test Gas Cleaning

Test gases shall be cleaned to conform to the Class 1 requirements of LMSC Specification LAC 3150, and shall meet the moisture limit prescribed in LMSC Specification 1415562 (20 ppmv). The gas supplied to the vehicle to perform tests shall be sampled

to determine the moisture content prior to charging the system. Particle contamination checks of the test gas shall be made prior to the initial connection of the test supply gas to the system. Test gases shall conform to either the Type I, Class I, Grade B requirements of Federal Specification BB-N-411 or to the Type I requirements of MIL-P-27401.

9.4.6 Moisture Content

All gas used in testing and final pressurization shall be filtered and dried. Moisture content of the gas shall not exceed 20 ppmv. If at any time there is evidence that the attitude control system might have "breathed," a gas sample shall be taken from the system and tested for moisture content. The entire system shall be evacuated if moisture is in excess of 20 ppmv. Evacuation shall be in accordance with the requirements of LMSC document A055800.

9.4.7 Propulsion System Leak Checks

Prior to performing the propulsion pressurization system leakage tests, the propulsion system monitoring tool (PSMT), which includes the helium sphere monitoring tool, shall be removed and a leak check performed on the capped and plugged ports. While removing the PSMT and installing the applicable launch-base-installed items (LMSC Drawing 1389603 or superseding document), a positive pressure shall be applied. Subsequent to the installation of flight hardware, the pressurization system leakage rate shall be checked around each line, fitting, and other hardware affected by the removal of the monitor tool. Leak tests and allowable leakage rates shall conform to specifications in the vehicle service and flight-readiness document (LMSC-1420834 or equivalent). The following propulsion system leak tests shall be performed:

- High-pressure static leak check (3600 psig helium)
- Propulsion tanks static leak check
- Engine static leak check including propellant isolation valves
- Moisture check
- Propulsion regulator flow check

9.4.8 Component Static Leak Checks

Component static leak checks shall be performed on the following in accordance with component specifications and the vehicle service readiness-flight document:

- Horizon sensor (if applicable)
- BTL (WECCO) guidance package

The pressure test performed on the horizon sensor heads (if applicable) shall demonstrate compliance with the horizon sensor head pressure test of LMSC Specification 1419628 or superseding document. If the horizon sensor head pressure is found to be outside the limits imposed by the specification, the LMSC Chief Systems Engineer shall determine the next course of action. The testing organization will not repressurize the horizon sensor heads except under the cognizance of the responsible systems engineer and the vendor representative.

9.5 CRADLE MATING WITH AGENA

If the vehicle-supporting cradle (Fig. 5-2) is new, it will have been checked out at the factory both for orbiter interfaces and for Agena interfaces. If the cradle was previously used, it will have been completely refurbished and checked out at the shuttle Maintenance and Refurbishment Facility. To ensure that the cradle is within acceptable tolerances, physical dimensions, alignment, and warpage of the cradle will have been checked in receiving inspection or shall be completed prior to Agena mating. In addition, free operation of deployment release latches shall be checked before mating in accord with LMSC assembly and installation drawings.

Also prior to mating, Agena alignments and other checks requiring easy access around the Agena will have been completed.

The Agena vehicle will be mated to the vehicle-supporting cradle and propellant tank supporting rings. For transportation of the integrated shuttle payload after cradle mating and prior to installation in the orbiter, cradle supporting dollies that employ support points identical to those in the orbiter will be available as GSE. These dollies

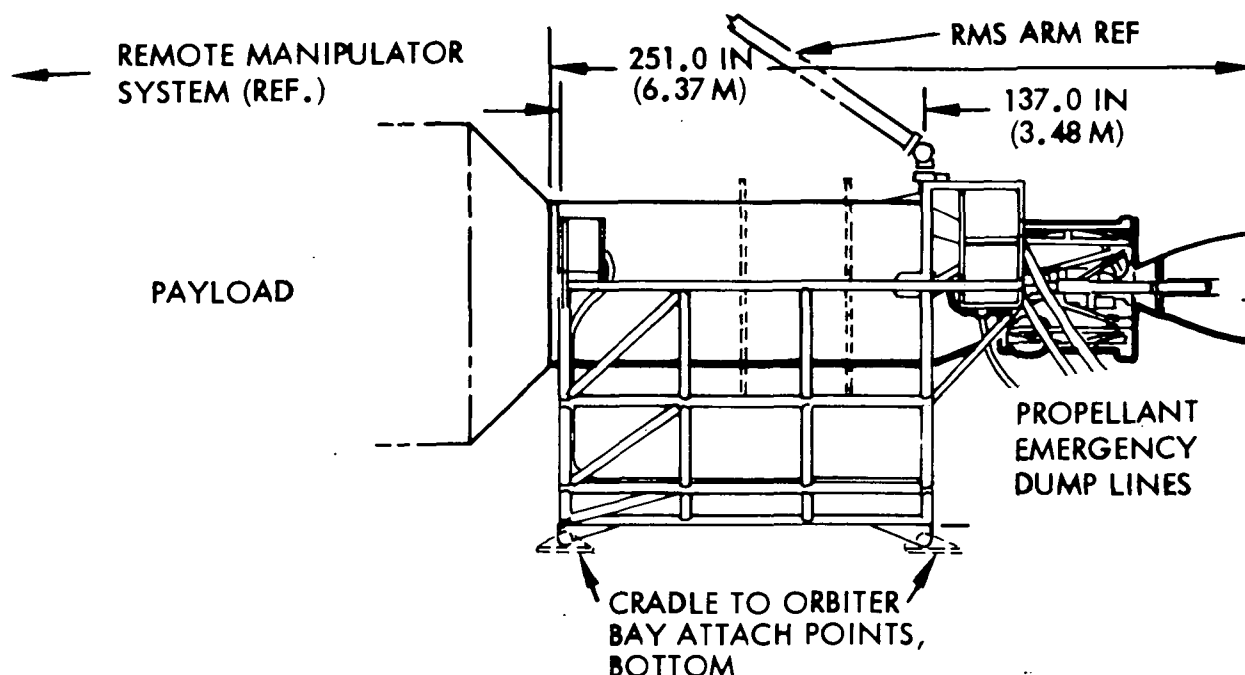


Fig. 5-2 Vehicle-Supporting Cradle

will be supplemented with power packages and/or environmental control units when required to support the integrated payload during movement at the launch base.

Mating of the Agena and the cradle shall be in accordance with LMSC drawings and documents. During the mating process, the following checks shall be made:

- Determine that proper clearances and fits have been maintained.
- Determine that proper deployment adjustments and gaps have been accomplished.
- Determine that separation mechanisms, plugs, and associated equipment are properly installed and positioned.

After mating, the Agena release pins in the cradle will be adjusted and functionally tested. The umbilical fuel and oxidizer disconnect and retract mechanism shall be operationally checked. After the retraction test, the fuel and oxidizer quick-disconnects and retraction mechanism shall be assembled and leak-checked.

NOTE

For subsequent tests of electrical continuity after installation in the shuttle payload bay, no disconnect of the fuel/oxidizer disconnects nor operational tests of the retraction mechanism shall be permitted. Continuity of the following circuits shall be assured subsequent to this test through test probe points on the following circuits:

- Retraction mechanism power and ground
- Deployment system power and control
- Agena latch release system power and ground

9.6 PAYLOAD MATING

After GSE compatibility has been demonstrated (COMPATS), the objective of simulated flight systems test is to validate the flight-readiness of the Agena/payload interface and integration. Therefore, prior to the simulated flight systems test, the following payload inspections and installations shall be performed. Specific payload-related activities will be covered by separate payload specifications and documents.

The payload mating surface on the Agena shall be checked and verified to specification for flatness and sealing.

The payload shall be removed from the shipping container and visually inspected. Surfaces mating with the Agena shall be examined and checked for flatness, if necessary. Plugs and other physical interfaces shall be examined for damage or possible bent pins. The payload contractor shall perform any necessary checks and tests to validate the payload equipment and verify payload flight-readiness prior to the scheduled mating with the Agena. An Agena interface simulator may be required.

Payload mating shall normally be accomplished by hoisting and mating while the Agena is in the vertical position. However, there are no vertical or horizontal constraints on Agena position for payload mating purposes.

After installing, attaching bolts shall be torqued. Electrical connections between the payload and the Agena shall be made before system test.

If applicable, payload pyrotechnic bridgewires shall be checked and pyrotechnic installations made and tested. This can be accomplished before system test if desirable, or it may be preferable to install pyrotechnic devices after system test and engine servicing and before propellant loading as described below.

Inspection shall demonstrate compliance with payload interface and clearances of the final payload mate as specified in the Vehicle Flight and Readiness document. Final payload mate installation, attachments, and pyro installations shall be photographed from front and side views as specified by the LMSC Chief Systems Engineer.

9.7 BATTERY CHECKOUT AND ACTIVATION

Agena tug primary and secondary batteries shall be activated and checked prior to installation in the vehicle. Battery activation occurs concurrently with other prelaunch activities; therefore, it does not require a specific time frame in the readiness schedule.

Batteries shall be activated by the vacuum method and tested to demonstrate compliance with applicable paragraphs of Battery Activation Specifications LMSC-1418898 and LMSC-1416890 and the vehicle service and flight-readiness document, LMSC-1420834, or superseding documents; e.g:

- Examination of Shipping Container
- Examination of Battery
- Cell Terminal Hardware Cleaning
- Torque
- Volume and Specific Gravity
- Soak Period

- Filler Screw Reinstallation
- Cell Open-Circuit Voltage Test
- Electrical Surge Test
- Dielectric Resistance and Leakage Tests
- Open-Circuit Voltage Test
- Final Cell Inspection
- Pressure Relief Channel Test
- Pressure Seal Test
- Starting Procedure, Vacuum Methods

Battery activation sequence shall be as follows:

- Connect battery to vacuum and pump down.
- Insert electrolyte.
- Measure outgassing at each cell.
- Perform cell load and open-circuit checks.
- Seal cell caps.
- Load-check entire battery.
- Perform battery time/soak period. Check temperatures periodically and watch for any warmups.
- Perform leak pressure checks.
- Store in refrigerator at controlled temperature until required for installation. Monitor battery voltage every 24 hours. Load-check entire battery periodically, as specified.

9.8 SYSTEM TEST – SIMULATED FLIGHT

After the payload is mated with the Agena, a simulated flight programmed sequence of events test shall be performed to demonstrate the Agena/payload mating flight-readiness and proper vehicle response to vehicle-initiated commands. The vehicle shall be configured with the Agena and the payload mechanically and electrically mated. The test shall include:

- Verification of configuration hookup
- Pre-power switch conditioning
- Power on and warmup

- Payload
 - Agena interface checks
 - Power and control
 - RF command and telemetry (ground station control and monitor)
- Simulated flight
- RF interference checks

The tests shall demonstrate compliance with the simulated flight test requirements of the vehicle service and flight-readiness document (Reference: LMSC-1420834 or superseding document). Pneumatic systems shall be pressurized to test levels. The payload interface plugs, simulated dump connections through the orbiter, and cradle interface plugs shall be installed. Payload system pyros shall be simulated. Other pyros will be live and installed. Pyro test harnesses shall be installed and connected.

Flight program checkout shall be demonstrated in compliance with the vehicle service and flight-readiness document. The guidance computer shall be programmed from the flight, constants, and target tapes (if applicable) to validate flight tape loading and checkout procedures. The test will include the following tasks and items:

- Load flight tape
- Load constants tape
- Load target tape
- Memory dump via telemetry (TDWDMP)
- Enter optical azimuth (TDW AZI)
- ISA alignment (TDW ALN)

The successful conclusion of this test shall confirm systems flight-readiness prior to final servicing and shuttle mating.

9.9 PROPELLANT ISOLATION VALVES LEAK CHECK

Leak checks shall be conducted on the PIVs in the closed position following PIV actuation during system tests.

CAUTION

As presently designed, PIVs shall not be pressurized at fill or outlet ports while in closed position.

The propellant tanks shall be pressurized with helium or dry nitrogen and the leakage measured at the fill dump lines. Tests shall conform to the specification for PIV closed position leakage checks in the vehicle service and flight-readiness document, LMSC-1420834, and LMSC Specification 1419628 or superseding documents.

9.10 ENGINE SERVICING

Agena tug components shipped to the launch site separately from the Agena vehicle for safety and handling reasons will be installed after passing receiving inspection and completion of the Agena/cradle/dolly mating. Installations shall be in accordance with the vehicle service and flight-readiness document (LMSC-1420834) or superseding document and as specified in detail on the LMSC Launch Base Installed Items Drawing (LMSC 1389603, or equivalent). Explosives shall be handled only by specifically designated personnel. All work on engine and service kits shall be accomplished under cognizance of the Bell Aerosystems Company representative.

The engine shall be inspected for evidence of improper component clearance, clamping, lock-wiring, cleanliness, finish, torque stripes, and workmanship. All inspections, equipment installations, and leak checks will be performed during the servicing of the engine assembly.

The engine turbine gear case shall be drained, filled with flight oil, and a final installation check performed in accordance with the methods of the Propulsion System Servicing section of LMSC-1420834, vehicle service and flight-readiness document, the Engine

Turbine Gear Case paragraphs of the Launch and Hold Limitations specification, LMSC-1419778, and the Transmittal of Data document, LMSC/A926750, or superseding documents. Final preflight lubrication shall be performed with the vehicle in a vertical attitude.

The engine low-pressure leak test shall be conducted and verified.

The engine nozzle extension, starter assembly, and engine service kit items shall be installed. (NOTE: No start cans are installed on the multistart engine configuration.)

Main propulsion system functional testing shall be required only if engine exposure limitations are exceeded or if engine recycling is necessary. If functional testing is required, the following GSE is necessary for multistart engines:

- Special cart for multistart engines
- Bell Aerosystems functional cart and ground handling gear to check engine pneumatics
- Brayco cart
- Hydraulic test cart

The elapsed time between the performance of an MPS functional and leak test, as specified in LMSC Specification 1419628 or superseding document, and the Vehicle Launch and Hold Limitations specification, shall not exceed 38 days. This period shall include the factory and launch base dry periods and the propellant exposure periods. If this time limitation is exceeded or if the MPS launch base exposure period exceeds 38 days, tests in accordance with the following paragraphs of LMSC Specification 1419628 or superseding document shall be performed:

- Pneumatic Test Gas Sources
- Controlled Conditions
- Test Precautions
- Main Propulsion System Tests
- Engine Component Functional
- MPS Engine System Electrical Tests

- Main Propellant Pressurization and Feed/Load System Component Test
- Main Propulsion System Engine Leakage Tests
- Main Propellant Pressurization and Feed/Load System Component Leakage

9.11 PYROTECHNIC INSTALLATION

Before propellant loading, remaining pyrotechnic devices shall be installed. (NOTE: Any Class C pyrotechnic devices may have been installed at Sunnyvale.) Pyrotechnic handling and installation shall be in accord with approved safety procedures and the "Safety Guidelines and Constraints" paragraphs of this plan.

Prior to installing pyrotechnic devices, each bridgewire of each Agena pyrotechnic (ordnance) device shall be checked for bridgewire and insulation resistance. Bridgewire resistance shall be measured with a current of less than 10 milliamperes. The insulation resistance shall be determined by supplying a DC potential as specified for a minimum duration of 1 second between each connector pin and case. The bridgewire and insulation resistances shall be measured and checked to specification. Pyrotechnic circuit-testing shall be in accord with Agena Vehicle Servicing specification (LMSC-1420834) or superseding document. Pyrotechnic test harnesses shall remain connected in accordance with LMSC Drawing 1390139 or superseding document at all times after pyrotechnic installation and prior to arm plug installation except for disconnections required during mating operations.

After circuit testing, the pyrotechnic devices shall be installed in accord with the LMSC Launch Base Installed Items drawing. Pyrotechnic devices selected for vehicle installation shall have complied with Section 8 storage requirements of the vehicle service and flight-readiness document, LMSC-1420834, or superseding document.

Electrical plugs shall be installed on squibs and the plugs lockwired as specified.

Fusistor checks shall be performed following the final D-timer run.

9.12 BATTERY INSTALLATION

Prior to propellant loading, Agena vehicle batteries shall be installed, shimmed, and connected as specified on the LMSC Launch Base Items Installation drawing (also refer to LMSC Battery Connection drawing 1385915 or superseding drawing). Battery activation, test, and monitoring shall have been initiated approximately 4 days before installation in accord with this plan. (NOTE: Battery activation requires a minimum of 72 hours.) Battery installation also shall be preceded by a preliminary battery fit check which may have been performed at LMSC Sunnyvale prior to shipment.

The flight batteries shall be installed in the vehicle in the areas listed in the LMSC Launch Base Installed Items specification. Batteries shall be vented as specified in the Shuttle Agena Launch Base Installation specification and resealed just prior to installation in the vehicle. Each battery shall be installed by battery serial number in the position specified for that particular vehicle and flight. After installation, the following information shall be transmitted to the LMSC Agena tug Chief Systems Engineer as soon as possible:

- The thermistor calibration curve for each battery installed in the vehicle. (These curves are generated by the vendor and packed with each battery.)
- Identification of each battery by serial number and exact installed location.
- Battery temperature and current sensor test results obtained during the battery activation.
- Battery activation data (all voltage tests, surge performance, etc.) as specified on the Battery Activation specification.

The maximum elapsed time from activation to launch for the various batteries installed in the vehicle is limited only by the requirement that the aggregate sum of the wet stand time and the flight usage requirement be less than or equal to the maximum use time allowable from the time of activation specified in LMSC Battery Activation specification 1416890 or superseding document.

Prior to orbital deployment, the Agena tug shall continue to draw any power requirements from GSE prior to orbiter mating and from the orbiter power bus after mating. It is recommended that not more than 45 ampere-hours be removed from the Agena batteries prior to orbital deployment. Batteries shall be vented as specified.

Battery monitoring shall be required after installation as specified under "Safety Guidelines" in this plan. Normally, there will be no requirement to remove batteries because of an intervening 14-day storage period.

9.13 PROPELLANT LOADING

Propellants shall be loaded with the Agena in the vertical attitude. The tank vents are located at the high points of each tank for gas expulsion during loading and for gas pressure relief.

For multistart engines, regulation system flow and flow rates shall be checked before propellant loading.

Leak-detection equipment for both UDMH and IRFNA shall be provided from the start of propellant loading until liftoff. The UDMH detector shall be sensitive to UDMH concentrations between 0 and 50 ppm in air, and the IRFNA detector shall be sensitive to NO₂ concentrations between 0 and 250 ppm.

Continuous monitoring of the propellant leak detector recorders is required from the time these are in operation just prior to vehicle propellant loading to liftoff.

All leakage indications shall be reported and recorded immediately when detected. These shall include rates, times of occurrence, and any other pertinent information. The following requirements define the leakage rates and concentrations which,

if detected, shall be cause for evaluations, investigations, and corrections before continuing propellant loading or proceeding with countdown:

a. UDMH Leakage Indications

- (1) Increase above the static or calibrated fluctuations on the meter readouts or recorders shall require evaluation to determine if the leakage indications are valid.
- (2) Indications of constant or increasing leakage rates or leakage concentrations which maintain levels at any value in excess of the static or calibrated fluctuations shall require investigations and corrections.

b. IRFNA Leakage Indications

- (1) Increase above the static or calibrated fluctuations on the meter readouts or recorders shall require evaluation to determine if the leakage indications are valid.
- (2) Indications of constant or increasing leakage rates or leakage concentrations which maintain levels at any value in excess of the static or calibrated fluctuations shall require investigation and correction

c. Combined UDMH and IRFNA Leakage Indications. Simultaneous indications of UDMH and IRFNA leakages shall not exceed the static or calibrated fluctuations of meters or recorders.

d. Visual Observations and TV Coverage. TV shall be used to provide additional coverage of possible propellant leakage when possible.

Detailed leakage monitoring procedures shall be followed in accord with the Launch and Hold Limitations specification (Reference: LMSC 1419778 or equivalent).

The propellant tank pressures shall be monitored and controlled at all times to prevent reversal of the common bulkhead between the oxidizer and fuel tanks. Fluctuations in ambient temperatures and pressures or variations in tank pressures must never be allowed to cause the aft (oxidizer) tank pressure to exceed the forward (fuel) tank pressure. Tank pressures shall never be less than atmospheric pressure.

During propellant loading, the propellant shall be recirculated in the propellant transfer unit for temperature conditioning. The required propellant loading weight shall be set on the unit scales, and this unit will automatically stop pumping propellants to the Agena

at the predetermined value. The weight of propellant required to fill the GSE plumbing will be properly accounted for. About 10 percent of fuel shall be first loaded. A hold will then be made to assure a liquid-tight system by monitor of the vapor sniffers located below the Agena. Then 10 percent of oxidizer shall be loaded. A similar second hold will be made and the operation monitored. Following this, the fuel and oxidizer tanks will be filled from their respective propellant transfer units. The helium sphere shall be partially pressurized before disconnecting from the tank vents. Fuel and oxidizer fill disconnects will remain connected to function as propellant dump lines.

After propellant loading, the engine start tanks shall be filled as specified for multistart engines in the vehicle service and flight-readiness document.

During propellant loading, the propellant temperatures shall be maintained within the specified limits. Particular care shall be taken to keep the propellants and all handling equipment free of contamination by dirt or moisture. Even small particles of foreign matter may clog valves and small orifices essential to the satisfactory operation of the propulsion system. The UDMH fuel shall be transferred from its storage facilities to the vehicle in a closed system to prevent exposure to atmospheric oxygen. Exposure could cause fuel deterioration and performance loss. The IRFNA oxidizer also shall be protected against excessive atmospheric exposure by transfer in a closed system identical to that used for the fuel.

Both fuel and oxidizer propellant samples shall be taken from the propellant transfer sets and an analysis performed within 10 days prior to propellant loading into the vehicle. The analysis shall conform to the specifications of the Vehicle Flight and Readiness document. At any time propellants are unloaded or dumped from the vehicle, samples shall be taken and analyzed in accordance with the aforesaid specifications. To ensure a representative sample of propellants, thorough circulation and strict adherence to accepted sampling procedures are required.

The propellant loads for each vehicle shall be as specified in the vehicle prelaunch message.

After propellant loading and the filling of the engine start tanks, the PIVs shall be closed and the following sequence followed immediately:

- a. The engine shall be purged with dry nitrogen gas. Pressure shall be applied through specially provided ports (with plugs removed) adjoining the engine pump pressure sensing ports. Purging shall continue until effluent gas meets the dryness requirements specified for the purging gas or until a TBD dryness requirement is met before pumping down with a vacuum.
- b. Propulsion system pressure transducers shall not be removed or disconnected.
- c. Plugs shall be reinstalled at the special purging ports and safetied as specified.
- d. Propellant fill connections shall be connected to an aspirator or to a vacuum source for drying engine and fill lines and to the propellant storage tank as shown in Fig. 5-3. (NOTE: The fitting for connecting the cradle dump line to the shuttle interface unit shall be used. The cradle-Agena quick-disconnect, which has been leak-checked previously, shall not be broken.)
- e. Emergency dump actuation circuits between the dump actuation control and both PIVs at the selector valves shall be verified.
- f. The selector valve shall be opened to the vacuum connection.
- g. Propellant fill and engine propellant feed lines shall be pumped down until the discharge side of the vacuum pump meets the dryness requirements of purging gas or TBD limits.
- h. During this period and prior to pneumatic system pressurization, propellants shall be drained as specified in subsequent paragraphs if a leak is detected or emergency arises.
- i. Pneumatic system pressurization shall proceed to provide dump and leak-check pressurization as described in par. 9-15 of this plan.

Maximum propellant exposure time limitations are based upon the following maximum times after propellant loading:

- a. Maximum of 14 days of storage between propellant loading and mating with the shuttle orbiter.
- b. Maximum of 18 days from propellant loading to launch, allowing a total of 4 days (after a maximum 14-day storage) for payload installation and checkout, orbiter erection, shuttle mate and checkout, prelaunch operations, countdown, and launch. The 4 days can be extended if the storage period is correspondingly shortened.

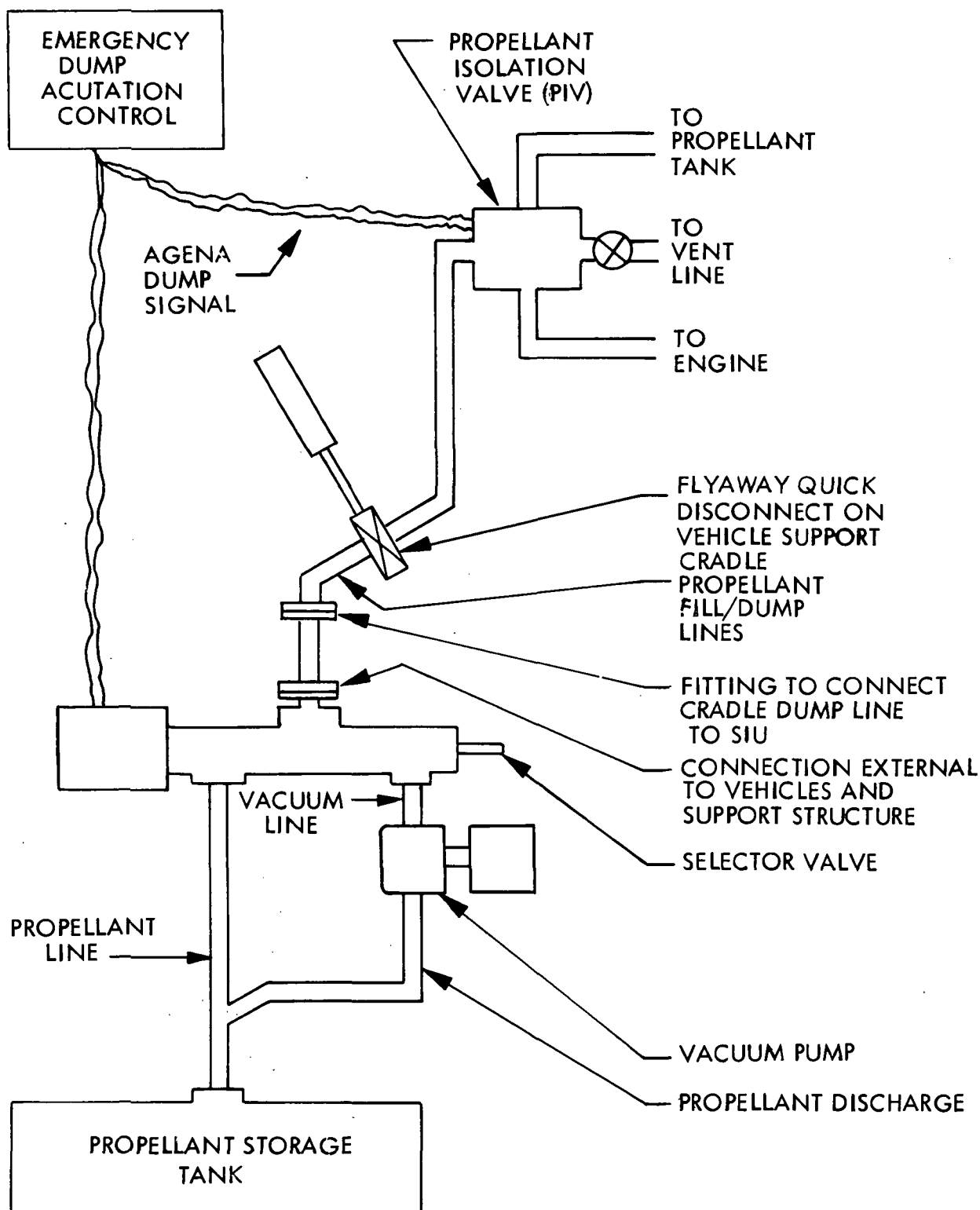


Fig. 5-3 Schematic of Setup to Dry Propellant Lines and Engine

If either of these periods is exceeded:

- a. The fuel and oxidizer systems shall be flushed with the propellant transfer set which shall be installed within the Payload Processing Facility or by a portable flushing and purging trailer. Propulsion system flush shall be performed as described in the Propulsion System Flush paragraphs of LMSC-1419778 or superseding documents.
- b. The oxidizer fill coupling shall be replaced if exposed to liquid or vaporized oxidizer for a period exceeding the above limits.
- c. The oxidizer vent coupling shall be replaced if exposed to liquid or vaporized oxidizer for a period exceeding the above limits.
- d. The oxidizer propellant isolation valve shall be replaced if exposed to liquid or vaporized oxidizer for a period exceeding the above limits.

An engine contamination inspection shall be performed after any system flushing operation or any disassembly and reassembly.

Similar limits and updating action shall be taken for the secondary propulsion system (if applicable), depending upon the system options and servicing requirements of the LMSC vehicle service and flight-readiness document applicable to the particular Agena tug under test.

Following propellant loading and helium and N₂ pressurization, the fuel and the oxidizer tanks shall be pressurized at (TBD) regulated (approximately 16 psig) pressures (as specified in the vehicle service and flight-readiness document), and the PIVs shall be statically leak-checked in the closed position. Safety precautions to prevent bulkhead reversal as previously specified shall be observed. No leakage of propellant (fuel or oxidizer) shall be permitted at the fill/dump lines.

Immediately after completion of the final leak check of the PIVs in the closed position, the propellant fill/dump lines shall be connected between the vehicle-supporting cradle and the propellant dump tanks as specified in the Safety Guidelines section of this plan. The Agena shall remain hooked up and ready for emergency dump except as indicated in this plan.

After completion of final PIV closed leak checks and unless otherwise specified herein, in the vehicle service and flight-readiness document, or in approved supporting specifications and procedures, pressurization of the propellant system shall conform to the following:

- a. The entire propulsion system shall at all times be pressurized at (TBD) (approximately 2.5 psig) with helium or nitrogen. This pressure shall be periodically monitored, and the system shall be repressurized when and if the pressure drops to 1.0 psig. Whenever the system is opened and not capped, a positive pressure of 1.0 ± 0.5 psig shall be maintained during the entire period. However, if the system has been exposed to propellants, it shall then be required that all lines be capped immediately after they have been opened. At no time shall the propulsion system remain in a condition that would allow it to "breathe."
- b. A constant pressure between 2.0 and 14 psig (20 psig maximum allowable surge) shall be maintained on the oxidizer pump lip seal whenever the system is exposed to propellants.
- c. An inert atmosphere between 0.5 and 1.5 psig shall be maintained at the propellant pump overboard drains whenever the system is exposed to propellants.

CAUTION

The pressure on the oxidizer overboard drain shall at no time exceed the pump lip seal pressure.

- d. With the propellants in the propellant tanks, the pressure in the main helium sphere shall not be lower than the pressure in the tanks.
- e. The system pressure shall be reduced to provide purging pressure of 2 to 3 psig prior to correction of any system leaks.
- f. The engine cavity shall be pressurized to TBD psig with dry N₂ gas after being dried out.

If an abort is required during propellant loading or if it is necessary to dump propellants in a nonemergency situation because a schedule change will cause specified maximum propellant exposure times to be exceeded, propellant draining shall be performed as follows.

A closed-loop propellant loading system is formed by the propellant tank fill/dump lines and the tank vent lines connected through the pneumatic control system. Thus, the normal process of venting the tanks during loading can be reversed for offloading propellants should this be required because of tank leakage. This reverse flow is provided for by valves in the pneumatic control system. These valves allow the propellants to be drained by gravity from the vehicle back into the weighing tanks. When the propellants are completely drained, the entire fuel and oxidizer systems must be flushed and dried.

If the propellant system is dumped or flushed subsequent to engine servicing, the turbine gear case shall be drained. After draining, the turbine gear case shall be serviced for flight in accordance with the engine servicing requirements specified in this plan.

After propellant draining, the propellant tanks, engine, and associated plumbing shall be flushed and purged as described below and as specified in detail in LMSC-1419778 or superseding document. The following precautions shall be observed to prevent possible injury to personnel or damage to the vehicle.

- a. See LMSC document A926850 for the hazards and precautions to be observed in the handling of the flushing fluids and propulsion system propellants.
- b. The cleanliness level of any gas introduced into the vehicle propulsion system shall meet the requirements of Specification LAC 3150. The moisture level shall not exceed that specified in the vehicle service and flight-readiness document (LMSC-1420834) or superseding document).
- c. All flushing operations involving the engine shall be accomplished in accordance with the methods prescribed in LMSC-A926750.
- d. Propellant tanks shall be vented while liquid flushing fluids are being drained to prevent negative tank pressures and possible collapse of the tank assembly.
- e. The aft (oxidizer) tank pressure shall never be allowed to exceed the forward (fuel) tank pressure to prevent possible damage to the common bulkhead.

- f. Tank pressures shall never be less than atmospheric to prevent possible breathing. If "breathing" does occur, the system shall be flushed within 24 hours. After draining, the fuel tanks shall be pressurized to 5 ± 0.5 psig and the oxidizer tank to 2 ± 1.0 psig with dry, filtered helium or nitrogen. The propellant isolation valves shall be in the full-open position.
- g. At no time shall the propulsion system remain in a condition that would allow it to breathe.
- h. All flushing fluids introduced into the vehicle shall be filtered through a 25-micron absolute filter.
- i. Flushing fluids used shall meet the specifications of LMSC-1419778 or superseding document.
- j. The entire oxidizer system shall be flushed with inhibited water prior to removal of any components that have been exposed to oxidizer to ensure against possible hazard to personnel in the handling of oxidizer-contaminated parts. Preliminary flushing shall be accomplished by introducing the required flushing agents through the oxidizer vent coupling, filling the tank, and draining the effluents at the tank outlet.

After preliminary flushing operations have been completed, the following operations shall be performed prior to final flushing.

- a. The pyro helium control valve shall be removed immediately after the preliminary flush and the fuel and oxidizer passages of the valve flushed and purged with flushing agents.
- b. The engine gas generator feed line venturis shall be removed and replaced with mock venturis.
- c. The engine oxidizer valve shall be removed. The engine oxidizer valve and gas generator venturis shall be flushed in accordance with LMSC-A926750 as separate components. The oxidizer valve must be flushed with each flushing fluid sufficiently to remove the previous fluid. NOTE: The oxidizer valve requires 150 psig maximum to open.
- d. All propulsion system pressure and temperature probes shall be removed from the vehicle.
- e. All propellant pressurization system transducers shall be removed from the vehicle and flushed with the liquids as specified, then purge-dried prior to reinstallation on the vehicle.

The fuel system, including the engine fuel passages and associated pressurization lines, shall be flushed first with isopropyl alcohol, then with dry nitrogen gas. The flushing shall be accomplished by introducing the required flushing agents into the vent lines,

filling the tanks, and draining the effluents through the tanks outlets. The oxidizer tank shall be pressurized to 2 ± 1.0 psig during fuel tank flushing operations to prevent possible breathing.

The vented oxidizer system, including the main engine oxidizer passages and associated pressurization lines, shall be flushed by introducing the required flushing agents into the vent lines, filling the tanks, and draining the effluents through the tank outlets.

Flushing agents shall be applied in the following sequence:

- a. Inhibited water at 120° to 130° F
- b. Dry nitrogen gas
- c. Methyl alcohol
- d. Dry nitrogen gas
- e. Methylene-chloride
- f. Dry nitrogen gas

The fuel tank shall be pressurized to 18 ± 1 psig during oxidizer flushing operations to assure a positive pressure differential (fuel over oxidizer tank) across the common bulkhead.

The engine shall be purged with dry nitrogen at 115° to 125° F through the pump pressure sensing ports with the PIVs closed. Purging with the dry heated gas shall continue until the effluent gas meets the dryness requirements of the purged gas. All propulsion system pressure transducers shall be individually cleaned and purged dry before reinstallation on the vehicle.

The oxidizer and fuel isolation valves (PIVs) shall be actuated closed after each system flushing operation and shall be backflushed and purged through the PIV vent lines in the sequence specified.

9.14 PROPELLANT EMERGENCY DUMP

As stated under "Safety Guidelines" in the Policies and Constraints section of this plan, provisions shall be made for emergency dump of Agena fuel and oxidizer when the Agena

is in a vertical position, either in the Readiness Area of the Payload Processing Facility or installed in the orbiter. Included in the circumstances which may call for emergency dump are the following:

- A propellant leak which cannot be stopped
- An emergency in an adjoining area which may place the Agena in jeopardy
- Failure of air conditioning and insufficient backup
- A temperature/pressure problem
- An abort

Propellant dumping shall be capable of being initiated at the blockhouse associated with the Readiness Area or, when the Agena is installed in the orbiter, by the orbiter crew or by the orbiter ground station if crew is not onboard.

Propellant dumping control shall be by means of a switch at each of the various consoles controlling dump. This shall be a control which shall require at least two discrete, positive actions to initiate dump.

The dump control requires only that power be applied to the proper Agena circuits which open the propellant isolation valves and open pneumatic pressure to the propellant tank pressure regulators.

To prevent bulkhead reversal, the sequence of these openings is critical. The fuel tank pressure must always be higher than that of the oxidizer tank. Two requirements result:

1. The fuel tank pressure must be applied before oxidizer tank pressure.
2. The oxidizer PIV must open before the fuel PIV

Since propellant dumping provisions shall be included as a flight requirement, control of the dumping sequence shall be incorporated in the Agena systems and plumbing and are not needed in the dump control consoles.

9.15 PRESSURIZATION

The pressurization system shall be filled with helium when propellant loading is completed. During tests or operations requiring helium, the vehicle systems shall be pressurized and purged with a source conforming to the following requirements:

Helium shall conform to Bureau of Mines Standards, Grade A, Type I, filtered through 10-micron filters. The supply shall be capable of supplying gas at 3600 psig. The supply shall conform to the cleanliness requirements of LMSC Specification LAC 3150, Class 60,000. The moisture content of the helium shall not exceed 26.3 ppmv.

The helium loading equipment shall be adjusted so that the helium sphere pressure does not exceed the maximum specified pressure and so that the rate of pressurization does not cause the sphere to exceed the maximum specified temperature as defined in the vehicle service and flight-readiness document. Loading requirements for the 2880-psig helium sphere shall be as follows:

The loading rate shall be adjusted to prevent high compression temperatures during final pressurization. Sphere temperature shall not be allowed to exceed 165°F at any time. The design loading curve and the permissible loading range will be specified in the Vehicle Flight and Readiness document.

When the helium gas storage spheres of the vehicle are vented, the service fluid line of the ground half of the gas fill valve shall be pressurized to within 600 psi of the pressure in the sphere to be vented before pressuring the actuation port of the ground half.

The nitrogen pneumatic system shall have been maintained between 15 and 150 psig during handling, standby, and nonoperating periods.

The nitrogen used for vehicle systems pressurization and testing shall meet the cleanliness and moisture requirements specified in the vehicle service and flight-readiness document.

For tests or operations requiring nitrogen, a supply conforming to the following requirements shall be used:

Nitrogen shall conform to Federal Specification BB-N-411, Type I, Class I, Grade B, or to MIL-P-27401, Type I. The source shall be capable of supplying gas at 3600 psig. The supply shall conform to the cleanliness requirements of LMSC Specification LAC 3150, Class 60,000. The moisture content shall conform to Federal Specification BB-N-411 or to MIL-P-27401, except that the gas supplied to the pneumatic attitude control system shall not exceed 20 ppmv of moisture.

The moisture content shall be determined in accordance with LMSC Specification 1415562 or superseding document. The gas to be supplied to the vehicle shall be sampled to determine moisture content and particulate contamination prior to connection of the test gas source to the system.

A safety relief valve shall be installed in the pneumatic supply gas system when the pneumatic supply is at pressures greater than the test pressure of the attitude control system. The relief valve shall be located downstream of any shutoff valves installed in the charging supply line. The relief setting shall be less than 10 percent above the vehicle test pressure.

Pneumatic system pressures shall be applied during all tests, and loading operations shall be performed in accordance with the applicable safety and test pressures specified herein and in supporting specifications and documents.

Care shall be taken during any system depressurization to prevent the application of reverse pressure across the pneumatic regulator; that is, the inlet pressure shall always equal or exceed the outlet pressure. Below 200 psig, the blowdown rate shall not be greater than 100 psi per minute. Prolonged blowdown shall be avoided because moisture may condense within the system under extreme blowdown conditions, even with initially dry gas. All blowdown below 200 psig shall be done by using the vehicle gas valves.

9.16 STORAGE AND STORAGE MONITORING

In the normal sequence of launch base events, after the Agena tug is mated to the payload and propellants are loaded the flight-ready Agena/cradle assembly will proceed into the countdown with orbiter compatibility checks (RF check) and installation into the orbiter payload bay. However, the Agena prelaunch operations are flexible and can accommodate schedule changes or delays in the payload or in the shuttle availability. In either case, the revised schedule may require storage of the flight-ready Agena at this point.

If the Agena payload has not been received, or if the shuttle schedule does not call for the Agena countdown to proceed, the Agena shall be stored in one of two conditions:

1. Dry storage prior to propellant loading
2. Stored with propellants loaded in a flight-ready status (or near flight-ready), awaiting orbiter availability

These two storage conditions are described below:

1. If the Agena payload is not available, this Launch Base Test Plan shall always be implemented through Sequence Item 5 of the Milestone Schedule (cradle checkout and mate). At this point, normally a hold and dry storage will be in effect since Sequence Item 8 (System Test) would have little value without the payload.

However, if schedule is critical, the customer may decide to waive a separate system test and risk a combined system test and RF check at Sequence Item 15. In this event, it may be decided to initiate storage and a delayed payload mate (Item 6) after battery installation (Item 12). Some environmental control (air conditioning) is required after battery installation, and safety monitoring is required. Any dry storage period prior to propellant loading shall be handled similar to factory storage, as specified in LMSC-1389601 or superseding document.

2. If the Agena payload has been installed, checked out, and propellants have been loaded, the Agena shall remain in a vertical upright position in the clean tunnel on the safety pad in the Agena tug Readiness Area. The following conditions shall be maintained:
 - (a) Leak-detection sensors on the Agena shall be connected and operating.
 - (b) Fuel and oxidizer dump lines to the Agena shall be connected to the corresponding fuel and oxidizer storage tanks.

- (c) PIVs and pneumatic system shutoff valves to the pressure regulators shall remain connected to the propellant dump console.
- (d) GSE power to the Agena shall remain connected and on.
- (e) Air-conditioning environmental control of the clean tunnel shall maintain a not-to-be exceeded temperature of (TBD)
- (f) The status of the Agena shall be continuously monitored with alarms for safety as outlined in the "Safety Guidelines" section of this plan
- (g) A complete status check of the entire Agena shall be recorded from the Agena telemetry every 24 hours. As a minimum, the status points listed in the go/no-go document shall be analyzed every 24 hours.

During any dry storage period,* the main propulsion system propellant feed and load system shall be maintained in accord with the Pneumatic Test Gas Sources and Controlled Conditions - Moisture Content paragraphs of LMSC Specification 1419628 or superseding document. Electrical, mechanical, or pyrotechnic disconnections will not be made.

The flight-ready Agena tug also could be stored with propellant and oxidizer loaded without the payload installed if the shuttle schedule dictated this requirement. In this case, the procedure of 2. above would be followed. However, this storage mode would be unusual since propellant loading is a short-duration operation that preferably should occur after payload installation.

9.17 POST-STORAGE INSPECTIONS

Since any Agena tug storage at the launch site will have been:

- Under closely controlled conditions
- Without handling or movement of the vehicle
- Subjected to continuous safety monitoring
- Subjected to periodic status check by telemetry

*Dry storage for engine and propulsion system: propellants loaded, PIVs closed, and engine and propellant fill lines purged

post-storage inspection will be minimal. Inspection shall include a:

- Visual inspection without actuation or removals
- Review of logbook items
- Review of previous telemetry analysis
- Complete status check of the last telemetry recordings

Flight-readiness activities shall proceed before completion of the last item above.

9.18 RF CHECK SIMULATING POST-DEPLOYMENT

After the shuttle orbiter is available at the launch site and before Agena/orbiter mating, Agena response to RF commands from the orbiter and receipt by the orbiter of Agena RF telemetry shall be verified. This will check the RF link between the orbiter and the Agena in the post-deployment mode, where the Agena shall be commanded from the orbiter and the orbiter shall:

- Monitor some Agena functions on the orbiter payload controller's console via the shuttle 25-KBPS data bus
- Relay Agena 62.5-KBPS telemetry to the shuttle ground station via the shuttle 256-KBPS telemetry link

This test requires the following orbiter systems:

- Agena command generator and cathode ray payload monitor at the orbiter payload control console
- Orbiter operational tie-in to the Agena telemetry recorder at the shuttle ground station
- Active RF transmission and reception to and from the Agena

Preferably, the Agena shall be in the Readiness Area and located so that it can radiate to and receive RF from the orbiter, possibly with reradiating equipment. The flight and constants tapes shall be installed.

The orbiter shall read out a simulated Agena flight program sequence. Agena response shall be monitored at the orbiter payload control console and Agena telemetry recorded at the shuttle ground station. The test shall demonstrate compliance with the flight

program checkout requirements of the vehicle service and flight-readiness document (LMSC-1420834 or superseding document). This test shall demonstrate compatibility and checkout of the command and telemetry via the orbiter/Agena RF link.

9.19 ORBITER/AGENA MATING

Prior to orbiter/Agena mating (Fig. 5-4), an Agena/payload service panel shall have been installed, checked out, and accepted as orbiter installed equipment to provide Agena-shuttle electrical and propellant dump line connections. Electrical plug connections will have been verified against an Agena simulator. Also, leak-detection sensors shall have been installed and verified as functional in the orbiter payload bay. Any previously installed Agena support cradle (as from an earlier checkout or flight) shall have been removed and returned for recycling. (The Agena deployment mechanism shall be part of the standard orbiter equipment.) Before mating operations are initiated, the orbiter shall be ready to:

- Supply power to the Agena
- Monitor Agena status
- Conduct electromagnetic compatibility (EMC) checks
- Receive the Agena installation in the payload bay; location and condition of payload attach fittings shall have been verified
- Receive dump line connections from the Agena cradle

The Agena shall have been mated to cradle and Agena payload, tested, checked out, with propellants and pyros loaded and flight-ready. At the initiation of mating operations, the Agena shall be in a vertical position in the Readiness Area associated with the Payload Processing Facility, enclosed in a clean tunnel or shroud, air-conditioned to a (TBD) temperature, and with propellant fill dump lines connected to storage tanks. Regardless of whether or not a storage period has intervened between Agena test/checkout and initiation of orbiter-Agena mating, Agena status shall have been monitored periodically as planned herein. No requirement for top-off of pressurization nor change in propellant load is anticipated.

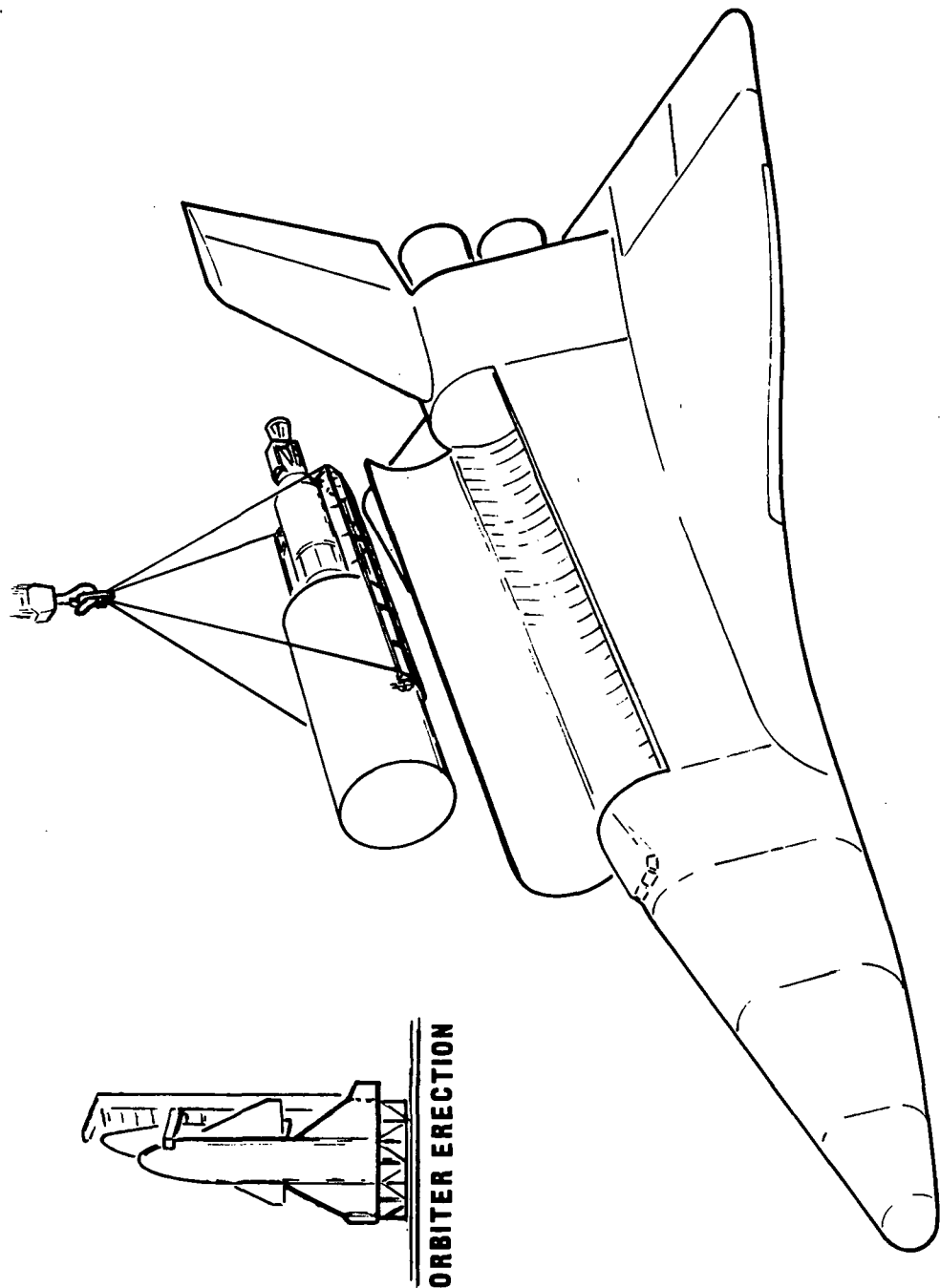


Fig. 5-4 Agena/Orbiter Mating

A telemetry readout shall be recorded and go/no-go items checked.

NOTE

This will be the last telemetry readout before a status check can be made through Orbiter systems from 8 to 16 hours later.

The Agena aft end shall be inspected visually. Any remaining pyrotechnic shorting plugs shall be removed, and arm plugs shall be installed.

Propellant dump lines and GSE power shall be disconnected. Portable monitoring and recording equipment (probably solid-state 24-hour recording devices) shall be installed temporarily on the cradle and connected to monitor the dual-purpose transducers until the Agena is installed in the orbiter payload bay. Continual monitoring of the safety status shall be maintained throughout mating operations, as specified under "Safety Guidelines" in the Policies and Constraints section of this plan.

The clean tunnel or shroud shall remain around the Agena and the environment controlled to (TBD) limits during transport and mating operations. A good electrical ground to the Agena shall be maintained during transport handling and mating. The propellant tank supporting rings and attach points shall be inspected and verified before moving the Agena.

The vehicle handling equipment and transporter shall be attached. If the vehicle is to be transported in the horizontal position, the vehicle shall be rotated to the horizontal. Proper gearbox orientation as described below shall be maintained.

The Agena shall then be transported to the orbiter at the mating site. If the Agena is transported vertically, rotation to the horizontal will occur at the mating site. The Agena will have been installed in the vehicle-supporting cradle in a manner to maintain

proper engine gearbox attitude. The proper attitude shall be maintained while the Agena is horizontal during transportation and afterwards during orbiter translation, with consideration given to the following:

- The engine gearbox shall be in the 6 or 12 o'clock position looking forward when the Agena is moved to a horizontal position. In this position, the oil level is below the oxidizer and fuel pump shaft seals, and no leakage can occur.
- If for any reason the gearbox is in the 3 o'clock position (looking forward) with the Agena horizontal, there is oil along the fuel pump shaft and seal when the pitch angle is from 10 degrees nose down to 90 degrees nose up. There should be no significant problems in this attitude, although minor leakage can occur over a 3- to 4-week period. The fuel seal drain cavity line shall be monitored whenever the Agena is in this position. If the Agena is moved to the horizontal position with the gearbox in the 9 o'clock position, leakage through the oxidizer seal is possible. To prevent this leakage, pressure shall be applied to the oxidizer pump lip seal whenever the engine is in this position, in accord with procedures specified in the Vehicle Flight and Readiness document. The oxidizer pump seal drain cavity shall be monitored under this condition.

The hoisting sling shall be attached to the cradle as specified in LMSC Drawing (TBD). No deviations shall be permitted in attaching or hoisting the Agena without LMSC Engineering authorization and approval. The hydraulic actuator gimbal locks and the proper nonflight items in the vehicle aft section shall be removed before hoisting. A final inspection of the vehicle aft section shall be performed to the requirements of the Launch and Hold Limitations document, LMSC Specification 1419778, or superseding document. The following checks shall be made:

- Inspection of antenna, solar array, or other deployment mechanisms to determine that there are no restrictions
- Verification that the fluid in the hydraulic power package sight gage is at the level specified in the Launch and Hold Requirements specification, LMSC 1419778, or superseding document
- Verification that there are no leaks

During mating operations, the Agena and orbiter shall be grounded to earth and electrically grounded to each other. After the Agena is installed in the orbiter bay, the Agena

shall be continually grounded to the orbiter and through the orbiter to ground. Before any connection or external equipment is used on or around the Agena, the following grounding connections shall be assured in this sequence:

- a. Orbiter to earth*
- b. Agena to orbiter*
- c. Agena to earth
- d. Equipment to earth*
- e. Equipment to orbiter*
- f. Equipment to Agena

The vehicle cradle with the Agena vehicle and payload shall be hoisted from the transporter or dolly into the orbiter payload bay. The cradle shall be fastened and secured to the orbiter tiedown fittings.

The propellant fill/dump lines from the cradle shall be connected to the orbiter propellant dump connections.

NOTE

Fuel and oxidizer fittings will be designed so that fuel lines can be connected only to the fuel connection and oxidizer lines only to the oxidizer connection.

NOTE

The propellant quick-disconnect fittings between the cradle and Agena at the retracting mechanism have been leak-checked and shall not be disconnected.

*Indicates primary ground to be maintained

The propellant dump connections between the cradle and the orbiter shall be leak-checked.

NOTE

Present design of the PIVs does not permit pressure at the inlet ports with PIVs closed. PIVs shall remain closed except for emergency dump.

The portable recorders used to temporarily monitor Agena safety shall be disconnected and removed from the cradle. The cradle electrical interconnect plug(s) shall be connected to the Agena/payload service panel and Agena safety monitored from the orbiter or shuttle ground stations. Electrical continuity between the orbiter and the umbilical retract mechanism on the cradle shall be verified at the retract mechanism probe points.

NOTE

The retract mechanism shall not be actuated nor quick disconnects disconnected.

Continuity of the following circuits shall be verified through test probe points on these circuits:

- Retraction mechanism power and ground
- Deployment system power and control
- Agena deployment latch release system power and ground

Agena-orbiter EMC shall be verified by turning emitters on and verifying telemetry. EMC shall be checked with payload bay doors open and again after doors are closed.

The payload bay shall be closed and environmental control to (TBD) limits shall be maintained.

As soon as the orbiter is erected, orbiter propellant dump ports shall be connected to propellant dump tanks (Fig. 5-5).

- AGENA OPERATIONS AND DATA ARE HANDLED THRU SHUTTLE DATA BUS AND GROUND COMMUNICATIONS LINKS.
- OPTICAL PATH REQUIRED FOR AGENA ASCENT GUIDANCE AZIMUTH ALIGNMENT.
- DUMP SYSTEM IS FOR PRE-LIFTOFF SHUTTLE ABORT MODE. SYSTEM IS NORMALLY DRY.

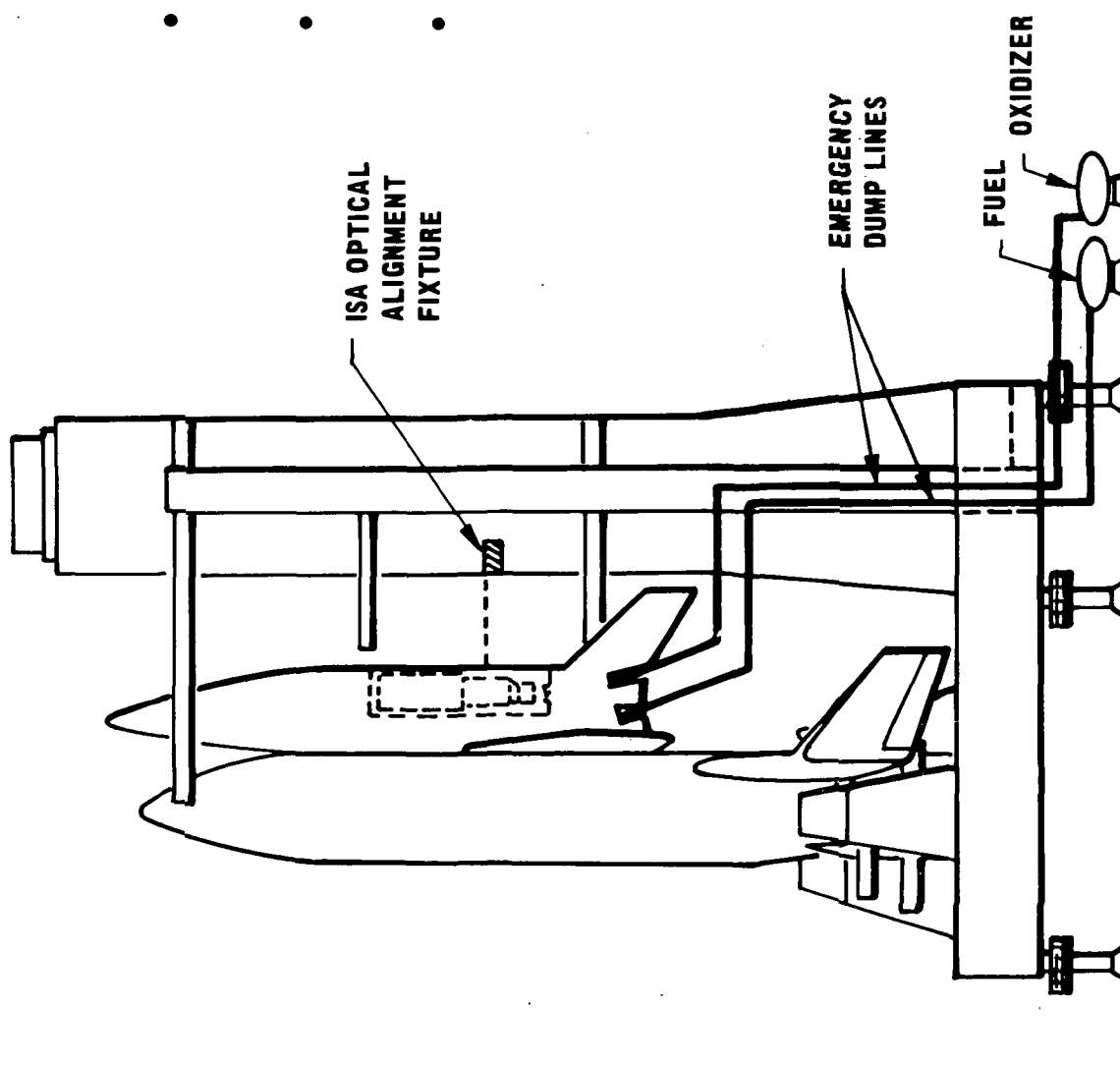


Fig. 5-5 Shuttle Pad Operations

Agena post-mating checks shall proceed immediately after Agena/payload installation with the orbiter in either the horizontal or vertical position. If demating is required, it can be accomplished either before or after a propellant dump. Demating shall be in accord with the Agena Chief System Engineer's direction.

9.20 POST-MATE CHECKS

After installation of the Agena in the orbiter payload bay and checkout of the orbiter/Agena electrical power interface, a final simulated programmed sequence of flight events test shall be performed to demonstrate vehicle flight-readiness and proper vehicle response to orbiter-initiated commands. The vehicle shall be configured as in the previously simulated post-deployment RF checks, except that the Agena tug and the shuttle orbiter shall be mechanically and electrically mated. The test shall demonstrate compliance with the simulated flight test requirements of the vehicle service and flight-readiness document (Reference: LMSC-1420834 or superseding document).

The Agena computer shall be programmed from the flight, constants, and targeting tapes (if applicable) from both the orbiter payload control console and from the Agena ground station and orbiter RF link via retransmission through the orbiter payload control console.

NOTE

The Agena ground station need for shuttle flight may be an integral portion of the shuttle ground station or may be a standard Agena ground station with an interface to adapt it to shuttle ground station signals.

Agena response shall be monitored at the orbiter payload command console via the shuttle 25-KBPS data bus and monitored and recorded at the shuttle ground station via the shuttle 256-KBPS telemetry link. The test shall demonstrate compliance with the flight program checkout requirements of the vehicle service and flight-readiness document (LMSC-1420834) or superseding document. This test shall demonstrate compatibility and checkout of the command and telemetry interface connection between the Agena and the shuttle interface unit.

9.21 STATUS CHECK AND COUNTDOWN MONITOR

Following verification of the orbiter/Agena power monitor and control checks and the Agena commanding and telemetry readout tests, the flight tape shall be left in the Agena computer and the Agena shall be passive except for telemetry and status checks until the final hours of countdown.

Agena safety shall be continuously monitored via orbiter systems as specified in the Safety Guidelines paragraphs of the Policy and Constraints section of this plan. Agena telemetry shall be read out and recorded at least once every 24 hours. Only go/no-go items will normally require analysis.

An update of the flight tape and the flight constants may be required during the day before launch. These can be performed in conjunction with the optical alignment check described below.

9.22 OPTICAL ALIGNMENT CHECK

At launch minus 30 minutes, an optical alignment check for the guidance system inertial sensor assembly (ISA) shall be performed in accordance with the vehicle service and flight-readiness document, LMSC-1420834, or superseding document. This will require an optical window in the orbiter payload bay door and no line-of-sight interference from the cradle as installed nor from shuttle GSE. Guidance computer programming and guidance system alignment shall generally follow the following plan.

In conjunction with the countdown sequence, the Agena guidance computer shall be programmed for flight, using a programming tape in accordance with the requirements of LMSC documents A965817 and B245685, or superseding documents. Subsequent to loading of the flight program, a constants tape and a target tape shall also be loaded. Both tapes shall conform to the requirements in the prelaunch TWX message. The constants tape shall be identified with the serial number of the particular inertial sensor assembly installed in the vehicle, and the target tape shall be identified with

the launch window being used. The final loading of the flight program shall be subsequent to all tests requiring the integrated test tape program and final performance of the computer memory and processor diagnostics. Successful loading of the three tapes shall be verified by a memory dump routine.

In conjunction with the countdown sequence, the guidance system shall be aligned with the alignment sequence programmed on the computer from the flight program tape. With the guidance system in the alignment mode, an optically determined azimuth shall be supplied to the computer, using the optical azimuth input routine. The azimuth entered shall be the actual orientation of the ISA porro prism measured, as specified in the vehicle service and flight-readiness document. The optical measurement of the ISA porro prism azimuth shall be accurate, as specified in the vehicle service flight and readiness document. When the optical azimuth is input to the guidance computer, the input azimuth shall be processed continuously.

After guidance system alignment, the ISA shall remain "on," powered from the orbiter power system into the Agena until Agena deployment.

Appendix

PROPELLANT LOADING AFTER AGENA INSTALLATION IN ORBITER

Propellants can be loaded into the Agena after it has been installed in the orbiter payload bay with minimal changes in this Launch Base Test Plan. This procedure may be desirable for any of several reasons, including the following:

- Maximum Propulsion Efficiency. When propellants are loaded near the time to launch, the quantities of the propellant load (and propellant temperatures) can be more precisely known and controlled.
- Safety. Amount of handling and activity around a loaded vehicle is reduced; length of time of exposure to a loaded vehicle is also reduced.
- Scheduling and Rescheduling Flexibility
- Facility Requirements

Propellant loading is a short-duration operation (approximately 1 hour) after preliminary preparations are completed.

A.1 CONFIGURATION CONSIDERATIONS

The following configuration considerations must be taken into account:

- Fuel and oxidizer vent line connections (if the payload bay must remain closed) or accessibility to these vent lines on the vehicle (if the payload bay is accessible) is required.
- Opening and closing of PIVs is required (no change in configuration – commandable through Agena command system).
- If Agena is connected to orbiter overboard dump lines, propellant fill connections could be made external to orbiter. This may impose slightly higher pressure and leak-check requirements on the orbiter dump lines and fittings.
- Drying of orbiter and Agena fill/dump lines and Agena engine will be required after propellant loading. This probably can be accomplished external to orbiter by attaching aspirator and/or vacuum pump to orbiter overboard dump connections, similar to method shown in Fig. 5-3 in this plan.

- Propellant head (pressure) required for loading propellants will be greater due to height of orbiter.

NOTE

Orbiter could be mated to booster, or loading could occur before orbiter-booster mating.

This will require further analysis of pumping requirements, line pressures, line lengths, etc.

- Propellant loading equipment (scales, pumps, etc.) will be located at orbiter site. (Propellant tanks will be required in either case if propellant dumping provisions are provided.)

A.2 CONSTRAINTS

These constraints apply during propellant loading after the Agena has been installed in the orbiter payload bay:

- Personnel shall not be on board shuttle during propellant loading (about 1 hour).
- Agena (and orbiter) must be in vertical position during propellant loading.

A.3 PROCEDURE CHANGES

To load propellants after the Agena has been installed in the payload bay requires few changes from the basic plan:

- All activities prior to orbiter mating and not related to actual propellant loading shall be performed as planned, including pressurization of helium and nitrogen spheres.
- Some safety monitoring procedures may be relaxed for periods prior to propellant loading.
- Propellant loading can be inserted at any point during the "post-mate check" period with the orbiter after electrical connections are verified. The preferred time would be following post-mate EMI and simulated flight checks.
- PIVs shall be closed following propellant loading.

- If the orbiter requires moving or rotation after propellant loading, dump line connections and reconnections and portable safety monitoring will be required.
- Safety monitoring after propellant loading shall be as previously planned.
- Engine and propellant line drying shall proceed as previously planned (Fig. 5-3), except that equipment shall be connected to orbiter propellant dump ports.
- Drying equipment shall be removed at a (TBD) time.

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